**Source monitoring in musical tasks: Cognitive processes involved in the unconscious plagiarism of musical ideas**

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**Declaration of Originality**

I, Miriam Ann Estelle Rainsford, declare that, to the best of my knowledge and belief, this thesis contains no material which has been accepted for a degree or diploma by the University or any other institution, except by way of background information and duly acknowledged in the thesis, and, to the best of my knowledge and belief, no material previously published or written by any other author except where due acknowledgement is made in the text of the thesis, nor does this thesis contain any material that infringes copyright.

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## Statement of Ethical Conduct

The research associated with this thesis abides by the international and Australian codes on human and animal experimentation, the guidelines by the Australian Government's Office of the Gene Technology Regulator, and the rulings of the Safety, Ethics, and Institutional Biosafety Committees of the University.

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Date 30 June 2017

**Abstract**

Unconscious plagiarism is a serious issue affecting a musician's livelihood, yet little scientific understanding presently informs court decisions on musical plagiarism. In contrast to deliberate copying, unconscious plagiarism occurs when an individual intends to create an original work, but retrieves another person's idea from memory, and mistakes it as their own. The cognitive mechanisms associated with unconscious plagiarism have so far only been tested in verbal creative tasks (e.g., generating category exemplars, or alternate uses for objects). In these studies, unconscious plagiarism was established to be a form of source monitoring error, where externally experienced ideas are confused as internally generated (Johnson, Hashtroudi, & Lindsay, 1993). The likelihood of unconscious plagiarism is greatly increased after improving others' ideas, as this involves similar processes to idea generation, thus, others ideas become confused as one's own (Stark & Perfect, 2006, 2008; Stark, Perfect, & Newstead, 2005). From this finding it was proposed that the number of high-profile cases of music plagiarism might be explained by the process of reworking and improving a composition (Perfect & Stark, 2008a). The present research investigated this proposal, by replicating Stark and colleagues' studies using a musical composition task.

In Studies 1 and 2, we developed and tested a computer-based method for investigating memory for melody, which was then extended to study the cognitive mechanisms associated with unconscious plagiarism in music, using the Brown and Murphy (1989) three-stage paradigm (Studies 3 and 4). This series of studies established two important differences between the cognitive factors which influence plagiarism in musical and verbal tasks. First, in the verbal domain, when recalling or recognising one's own ideas, source monitoring errors are increased specifically by

improving others ideas (Perfect & Stark, 2008a, 2012; Stark & Perfect, 2007; Stark et al., 2005). However, in music, we found no evidence that improvement alone increases plagiarism. Instead, re-exposure to ideas, regardless of task, increased plagiarism in music. Second, in verbal studies, the factors which increase plagiarism when generating new ideas are dissociated from those involved in recall and recognition. Generate-new plagiarism is not increased by idea improvement, instead, participants are more likely to plagiarise ideas of positive valence or high quality (Perfect et al., 2009; Perfect & Stark, 2008b; Bink et al, 1999). In music, however, we did not observe this dissociation between generate-new and recognition plagiarism. Instead, re-exposure increased the likelihood of plagiarism in both tasks.

Plagiarism of music is therefore more difficult to avoid than verbal content, because no single task can be avoided. In Study 4, we therefore tested an intervention designed to reduce plagiarism. If musical plagiarism depends on exposure, and thus, strength of the idea in memory (Marsh & Bower, 1993), than a distractor task should reduce memory strength for melodies, and thus reduce plagiarism (Glanzer & Cunitz, 1966; Petrusic & Jamieson, 1978). We administered a distractor task consisting of two minutes of randomly generated musical notes at two points during the retention interval of the paradigm. While we observed atypical results in comparison to Study 3, no evidence was found to suggest that the intervention reduced plagiarism. Participant familiarity ratings showed that the intervention did not alter memory strength. The task may have been too brief, or memory for melodies may have been well consolidated after idea generation and elaboration had taken place (Stark & Perfect, 2008; Stark et al., 2005). Across domains, unconscious plagiarism has proven to be difficult to avoid, even when source monitoring is improved (Hollins, Lange, Dennis, & Longmore, 2016; Macrae, Bodenhausen, & Calvini, 1999).

The theoretical implications of these studies are discussed in context of the literature on dissociations between implicit and explicit memory. Explicit memory is improved through elaborative processing, but implicit memory is improved through exposure and repetition priming (Schacter & Church, 1992). Musical knowledge is predominantly acquired implicitly, through exposure (Rohrmeier & Rebuschat, 2012). According to the source-monitoring framework (Johnson et al., 1993), where implicit memory is primarily involved, source monitoring processes are not engaged. Thus, our findings in music suggest that this dissociation between implicit and explicit memory systems extends to unconscious plagiarism.

Overall, this series of studies identifies that musicians are considerably more vulnerable to unconscious plagiarism than previously understood, and begins to provide a scientific basis for why this is the case. Specifically, our work highlights the limits of source monitoring processes in this domain. Given that unconscious plagiarism in verbal tasks occurs due to errors in source monitoring, reinforcing contextual source cues can protect against plagiarism (Hollins et al., 2016; Macrae et al., 1999). In music, if plagiarism occurs through exposure, no such protection is available. These findings have implications for the legal handling of copyright infringement cases, where no exceptions are presently made for unconscious plagiarism. Policy makers may therefore need to consider the degree to which a musician is held responsible in cases of unconscious plagiarism.

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"It's all the same, only the names will change"

Bon Jovi "Wanted, Dead or Alive" (1986)

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# Chapter 1

# Introduction

Unconscious plagiarism occurs when a person intends to generate an original idea, but instead retrieves another person's idea from memory, mistaking it as their own (Brown & Murphy, 1989). Copyright infringement lawsuits involving unconscious plagiarism are common, and impact upon the professional life and reputation of the defendant. Such cases attract particular attention when professional musicians, such as George Harrison, in the case of *Bright Tunes Music Corp v. Harrisongs Music, Ltd* (1976), testify in court as to the originality of their ideas, despite perceptible similarity to another well-known musical work (Müllensiefen & Pendzich, 2009). In this instance, the court ruled that Harrison had copied the song unintentionally (Perfect & Stark, 2008a), however, unconscious copying is not excepted from protection under *fair use* provisions under the United States Copyright Act of 1976 (2016), and so Harrison was ordered to pay royalties to Bright Tunes as compensation for his plagiarism (Müllensiefen & Pendzich, 2009).

Tests of copyright infringement under Australian, United States, and United Kingdom legislation* require that the plaintiff establish that the work was copied and not independently reproduced, and that a substantial degree of similarity exists between the defendants and the plaintiff's work (Wyburn & MacPhail, 2006). To do so, both works must be copyrightable, and the plaintiff's work must demonstrate exhibit a minimal degree of originality and creativity; commonly used chord progressions and musical motifs are not protectable (Müllensiefen & Pendzich, 2009). The plaintiff must also prove that the defendant had prior access to the work, although this is normally assumed if the song had received radio airplay. Crucially, the section copied must be sufficiently similar to and must represent a substantial

* Under the US Copyright Act of 1976 this is referred to as *substantial similarity*; in the UK Copyright, Design and Patents Act 1988 this is termed the *substantial part doctrine*. The Australian Copyright Act 1968 defines a *copy* to include reproduction of a *substantial part* of the work.

part of the plaintiff's composition (Cason & Müllensiefen, 2012; Müllensiefen & Pendzich, 2009). However, no empirical or legal definition exists of the degree of similarity required to constitute plagiarism (Cason & Müllensiefen, 2012). At present, the plaintiff and their legal team must only establish that the degree of similarity between theirs and the defendant's work is too great for the composition to be original. A further complication occurs in music, where very short segments of material may be considered sufficiently distinctive to contain the quality, or essence of the work (Australian Government Attorney-General's Department, 2012). The copying must be audibly similar, and determined to have been copied "by the ear as well as the eye" (*Austin v Columbia Gramophone Ltd.*, 1923), but such arguments are normally based on subjective analysis by musicological experts, and are not informed by scientific understanding of human auditory perception (Müllensiefen & Pendzich, 2009).

Understanding the cognitive mechanisms involved in unconscious plagiarism would therefore enable decision-making in such cases to be determined from a scientific perspective. However, a search of the literature[†] reveals no empirical studies of musical plagiarism, with the exception of Frieler and Riedemann (2011)'s study of the independent reproduction of ideas, which established that musicians may generate highly similar melodies independently, without plagiarizing, when given very limited source material. A three-stage paradigm has been developed to investigate unconscious plagiarism (or *cryptomnesia*) using verbal tasks (Brown &

[†] We performed computer searches of the PsycArticles, PsycINFO, Ovid MEDLINE, and PubMed databases, using the keywords "unconscious plagiarism" AND "music", "cryptomnesia" AND "music", "plagiarism" AND "music", and "plagiarism" AND "song-writing". We also searched the EBSCO database, using the keywords "unconscious plagiarism" AND "music" AND subject terms "psychology", "cryptomnesia" AND "music" AND subject terms "psychology", "plagiarism" AND "music" AND subject terms "psychology", and "plagiarism" AND "song-writing".

Murphy, 1989), but to date no studies have involved the experimental manipulation of cryptomnesia in a musical task.

**Empirical research using the three-stage paradigm**

Brown and Murphy (1989) developed a simple three-stage paradigm to investigate plagiarism in verbal creative tasks. In this experiment a category exemplar task was used, where participants were given a category (e.g., sports) and asked to suggest exemplars (e.g., football, tennis, cricket). In the first stage of the paradigm, the *generation* phase, participants are seated together as a group (or work with a computer partner) and take turns to generate solutions. Following idea generation, participants return to work alone to complete two further tasks, the *recall-own* phase, where they recall the ideas that they themselves contributed, and the *generate-new* phase, where they generate new solutions to the same creative task used in the *generation* phase. Plagiarism is defined as reproducing another participant's idea in any task (self-plagiarism was also identified separately when attempting to generate new responses), although a particular focus has been placed on understanding the different factors underlying plagiarism when recalling one's own ideas, and generating new ideas, as these tasks are involved in real-world plagiarism cases (Perfect & Stark, 2008a).

Across three experiments, Brown and Murphy (1989) found that rates of plagiarism in the recall-own and generate-new phases ranged from 7-14%, well above the baseline of 1.6% of ideas that would be plagiarized due to chance repetition alone in a category exemplar task (Gruenewald & Lockhead, 1980). The percentage of ideas plagiarized was consistently greater when generating new ideas than when recalling one's own ideas. This may potentially be explained by task order, as the generate-new task must follow the recall-own, thus, the participant has greater opportunity to plagiarize previously-experienced ideas in later tasks. In addition, Brown and Murphy (1989) suggested that episodic information associated with the source of the idea might decay more rapidly than semantic content. Thus, plagiarism may occur when the source of an idea is forgotten, but the content remains activated in semantic memory. Brown and Halliday (1991) also found that a longer time delay of 24 hours between idea generation and the recall-own and generate-new stages of the paradigm increased unconscious plagiarism. However, dissociations were later found between the factors increasing recall-own and generate-new plagiarism (Bink, Marsh, Hicks, & Howard, 1999; Perfect, Field, & Jones, 2009; Perfect & Stark, 2008b) suggesting that source monitoring functions differently in the two tasks.

**Unconscious plagiarism and the source monitoring framework**

Unconscious plagiarism is understood theoretically to be an error in source monitoring (Brown & Murphy, 1989). According to Johnson and colleagues' (1993) *source monitoring framework*, the source of an idea is not stored as a direct trace in memory. Source monitoring to determine the source of an idea is instead a metacognitive process. Judgements of source are made through evaluating perceptual qualities of semantic and autobiographical memories. Internally generated ideas are more likely to be associated with remembering the cognitive processes involved in generating and developing an idea (Johnson et al., 1993; Johnson & Raye, 1981). For a musician, this might involve recalling the moment of inspiration at which one began to hum an original melody in one's head, or remembering the processes involved in developing and extending the melody. In contrast, externally-generated ideas are associated with greater perceptual and sensory detail, for example, recalling the date and venue of a live performance, or the video projections and visual effects accompanying the band. Conscious recall of the source of an idea is therefore a higher-level process requiring a greater amount of differentiating information to simple old-new recognition. In contrast, primed, implicit memories do not require as much differentiation to be produced accurately, and thus do not engage source monitoring processes such as those described above (Johnson et al., 1993).

Source confusion may occur when the qualitative traces used to make source judgements overlap. Everyday occurrences of source confusion often involve similarities in contextual source information, for example, when parents confuse which sibling preferred strawberry to chocolate ice-cream, or who was responsible for breaking the bathroom window with a football (Macrae et al., 1999). Correct source monitoring therefore involves correct storage and evaluation of such perceptual and contextual information, as well as the decision criteria and processes involved, which may be either heuristic or deliberate and systematic (Johnson et al., 1993; Johnson & Raye, 1981).

Brown and Murphy (1989) proposed that the plagiarism elicited by their study occurred due to a reduced encoding of source material during the initial generation phase. Participants were most likely to plagiarize the person immediately preceding them, as attention to source would be reduced while preparing an answer, thus, the perceptual and contextual material required to evaluate the source of an idea would not be sufficiently encoded (Johnson et al., 1993). This *next-in-line* effect was, however, later avoided by using pseudo-random assignment to determine the next person in turn (Stark et al., 2005), or through computer-based administration (Marsh & Bower, 1993). Brown and Murphy (1989) also found that attention to and correct encoding of source was reduced by increasing task difficulty. When participants were asked to generate orthographically related category exemplars (i.e., beginning with the same letter), or to generate exemplars from new categories each time, plagiarism increased. Marsh, Landau, and Hicks (1997) also found that requiring participants to provide answers within a time limit of 20 seconds resulted in increased generate-new plagiarism as this limited the participant's ability to check that an idea had been suggested earlier. In separate experiments, Marsh and colleagues (1997) also showed that plagiarism reduced when source monitoring was improved by asking participants to report the source of ideas from the generation phase prior to generating new ideas, or when participants were given strong instructions to avoid plagiarism, resulting in stricter decision criteria being adopted. However, admonishing participants to avoid plagiarism does not function as an effective intervention against unconscious plagiarism, as 10% of others' ideas were still plagiarized by participants in this condition.

**Idea activation in memory: The Marsh & Bower model**

Strength in memory is one factor that may bias source monitoring. Ideas generated by oneself are associated with an increased perceptual fluency, familiarity, and availability in comparison to those generated by others (Johnson & Raye, 1981). Generating an idea causes it to be better remembered than when the idea is simply read aloud, a phenomenon termed the *generation effect* (Jacoby, 1978). Thus, ideas that are self-generated are expected by the participant to be stronger in memory (Johnson & Raye, 1981). Brown and Murphy (1989) proposed that participants may have confused others' ideas as internally generated if they had thought of the idea while another participant suggested it. If another participant's idea is recently activated and thus strong in memory, the increased familiarity with, and strength in memory of the idea might cause it to be confused as self-generated (Johnson et al., 1993). Related to this concept is the *it had to be you* (or *I'd remember if it were me*) effect (Johnson, Raye, Foley, & Foley, 1981). When a new item in a recognition test mistakenly elicits a very weak feeling of familiarity, participants are more likely to attribute it to an external source than themselves, because self-generated ideas are expected to be stronger in memory.

Marsh and Bower (1993) conducted a recognition test following a three-stage paradigm experiment where participants generated solutions to Boggle puzzles with a computer partner. Consistent with standard old-new recognition paradigms, half of the ideas presented were old, taken from solutions generated during the three-stage paradigm experiment, and half were new, using items that could legitimately have been generated using the same Boggle puzzles. Within the old ideas, three-quarters of these had been generated by the computer, and one quarter by the participant. Participants were most accurate in identifying both new ideas as well as their own contributions, despite these being only 12.5% of the test items. Marsh and Bower (1993) proposed an explanation for this effect through a strength-based signal-detection (SDT) model, based on Johnson and Raye (1981)'s model of reality monitoring (see Figure 1.1). Two criteria, indicated on the diagram as $T_{NEW}$ and $T_{COMPUTER}$, are set for the discrimination of own, others, and new items. The $T_{NEW}$ threshold delineates the point at which items with the weakest activation in memory are determined to be new, in accordance with the *it had to be you* effect. Items with the strongest activation in memory are assumed to be the participant's own, consistent with the generation effect. If activation in memory is above the $T_{NEW}$ threshold, but weaker than one's own items, a second criteria (indicated by the $T_{COMPUTER}$ threshold on the diagram) is set where the item is assumed to have been generated by the computer. The model was shown to have a good fit when tested against participant responses in the recognition task, explaining 92% of the variance in responses.

Unconscious plagiarism as well as giving-away of one's own ideas was therefore explained by Marsh and Bower (1993) as being due to differences in residual strength. Increasing the delay between the generation and recall-own phases has consistently been shown to increase plagiarism (Brown & Halliday, 1991; Marsh & Bower, 1993). As memory decays, both self- and computer-generated items would decrease in strength, increasing the overlap between the two distributions and thus increasing source confusion.

Plagiarism in the generate-new task was reduced when participants were asked to guess the computer's responses. This would have increased the strength of the computer's responses in memory to a level at which they overlapped with own ideas, thus increasing the distance between the distribution of both own and computer-generated ideas, and new ideas (Marsh & Bower, 1993). Avoidance of plagiarism when generating new ideas relies on the participant successfully discriminating old versus new ideas (cf. own vs others ideas in the recall-own task). This manipulation therefore made both computer-generated and own ideas easier to discriminate from new ideas. It was, however, surprising that predicting the computer's responses did not also increase confusion with own and computer-generated ideas in the recall-own task via the same overlap in own and computer-generated distributions, although this phenomenon was later observed in a similar experiment by Landau and Marsh (1997).

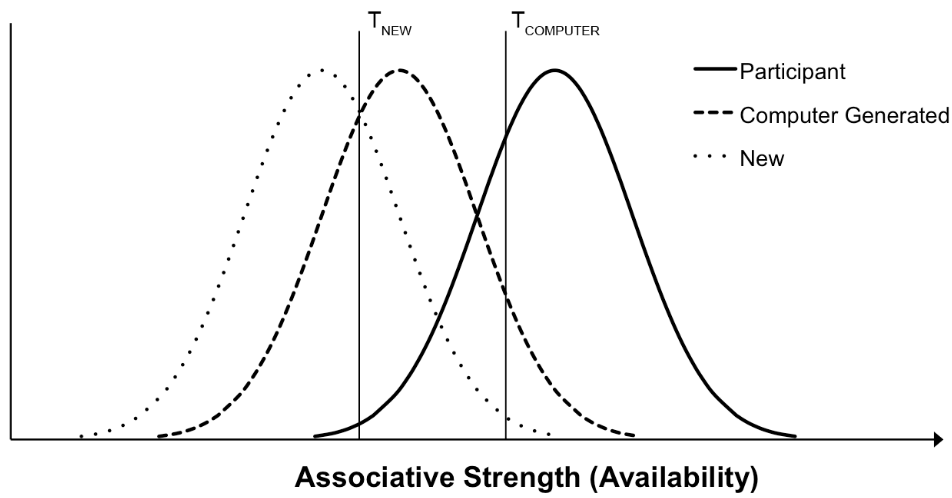


*Figure 1.1.* The Marsh and Bower (1993) model of relative strength of activation

Marsh and Landau (1995) tested this model using a lexical decision task (LDT) composed of own and others' items taken from the generation phase of a Boggle puzzle three-stage paradigm experiment, along with an equivalent amount of new items. Participants in the experimental group completed the LDT prior to the recall-own and generate-new phases, and were required to judge whether items presented were words or non-words. Words generated by the participant elicited the fastest response time, and new items the slowest, fitting the strength of activation model. Computer-generated items that were not plagiarized had a longer response latency than own items, but faster than new items. However, computer-generated items that were later plagiarized by the participant had a response time approaching that of own items, indicating that these items had sufficiently increased strength of activation in memory to be confused with the participant's own ideas.

**Factors that may increase or decrease the likelihood of plagiarism**

Johnson and Raye (1981) proposed that it would be possible to induce source confusion experimentally by manipulating the amount of contextual cognitive or sensory detail associated with the memory. Following the development of Brown and Murphy (1989)'s paradigm, a number of studies were conducted investigating factors that might inflate plagiarism by increasing the overlap of contextual information between the participants' and others' ideas.

Landau and Marsh (1997) extended Marsh and Bower (1993)'s Boggle puzzle study to investigate the possibility that increasing the amount of cognitive operations associated with others' ideas would result in increased plagiarism, as cognitive operations are normally associated with internally generated ideas. While Marsh and Bower (1993) failed to find this effect when participants were asked to predict the computer's solutions, Landau and Marsh (1997) proposed that the confusability of ideas in that experiment may not have been sufficiently strong. When cognitive operations associated with the computer's solutions were increased by requiring the participant to guess the word as it was revealed letter by letter, plagiarism increased in accordance with a source-monitoring explanation. In contrast, playing Boggle with a human, instead of a computer partner increased contextual information associated with external sources, reducing plagiarism.

Macrae and colleagues (1999) further demonstrated that increasing the perceptual similarity of an internal and an external source increases source confusion. Using Brown and Murphy (1989)'s category exemplar task, participants who generated ideas in same-sex pairs were more likely to plagiarize from their partner than opposite-sex pairs during the recall-own phase of the paradigm. Conversely, when their partner was present during the recall-own task, contextual cues associated with the external source were increased, and plagiarism was therefore reduced in comparison to participants whose partner was absent.

These findings confirmed the role of the source monitoring framework in unconscious plagiarism. When the amount of internal cognitive operations associated with others' ideas was increased, participants came to believe these were internally generated (Landau & Marsh, 1997), and when external environmental and sensory cues were increased, participants were more likely to correctly discriminate ideas generated by their partner from their own (Macrae et al., 1999).

**Idea elaboration and plagiarism**

Recent research into unconscious plagiarism has focused on the effects of elaboration on plagiarism. False memory studies have shown that a person may come to believe an event happened to them through repeated imagining of the event (Garry, Manning, Loftus, & Sherman, 1996). Stark and colleagues (2005) [‡] considered the implications of this finding when developing creative ideas. A musician rarely completes a work in a single setting, but will repeatedly edit the work. Motivic development of an idea is a well-known compositional device, where a musician elaborates over an initial motif to generate longer melodies (Levy, 1969). These forms of elaboration during the act of composition may offer the opportunity for unconscious plagiarism to occur, if others' ideas are incidentally recalled, and then edited, reworked, and incorporated into the new work, with the composer eventually coming to believe that the idea was originally their own (Perfect & Stark, 2008a; Stark et al., 2005).

[‡] Professor Timothy J. Hollins is the lead researcher on a series of studies investigating source monitoring and plagiarism, including papers by Stark and colleagues (Stark & Perfect, 2006, 2007, 2008; Stark et al., 2005), Perfect and colleagues (Perfect, Defeldre, Elliman, & Dehon, 2011; Perfect et al., 2009; Perfect & Stark, 2008a, 2008b, 2012), and Hollins and colleagues (Hollins & Lange, 2016; Hollins et al., 2016). Prof. Hollins changed his name from Perfect to Hollins in 2014. References to work conducted in his laboratory may therefore appear under either name according to the date of publication.

Stark and colleagues (2005) tested this proposal by asking participants to elaborate over ideas in different ways. Following idea generation using the Alternate Uses Task (Christensen, Guilford, Merrifield, & Wilson, 1960), elaboration of ideas was manipulated within-subjects. In the *improvement* condition, participants were asked to improve one quarter of the ideas generated, for example, improving the idea of a brick used as a doorstop by covering it with wallpaper (Stark et al., 2005). In the *imagery* condition, participants were asked to imagine a further quarter of the ideas and rate how effective they would be (e.g., whether a brick functions as an effective doorstop). A further quarter of ideas generated were *re-presented* and read aloud to the participants, but not elaborated, and the remaining quarter were assigned to a *control* condition, where they were not re-presented following idea generation. Correct recall of ideas in the recall-own task did not differ between the two elaboration conditions of improvement and imagery, thus, the levels of processing involved resulted in equivalent strength in memory (Stark et al., 2005). However, while plagiarism occurred in all conditions, only idea improvement increased recall-own plagiarism relative to control, a result which could not be explained by a memory strength account of plagiarism. Instead, Stark and colleagues (2005) proposed a source monitoring explanation. Idea generation and improvement involve highly similar cognitive operations, creating similar internally-associated source traces at encoding. At recall, this similarity in source cues would cause improved ideas to be confused as one's own. The cognitive functions involved in imagery are qualitatively different to idea generation, and thus do not increase source confusion (Stark et al., 2005).

This effect of idea improvement increasing plagiarism was replicated in a number of subsequent experiments (Perfect & Stark, 2008b; Stark & Perfect, 2006).

When others' ideas were repeatedly improved (arguably a common procedure in redrafting a creative work), recall-own plagiarism increased to 41% of ideas (Stark & Perfect, 2008). Source confusion after idea improvement was observed in recognition as well as recall. When a recognition test of own, others', and new ideas was used in place of the final two phases of the paradigm, others' ideas that had been improved were more likely to be claimed as one's own (Stark & Perfect, 2007).

Our research began at this point, where improvement of others' ideas was understood to be the most important mechanism affecting recall-own plagiarism. We proposed to test the proposal of Perfect and Stark (2008a) that idea improvement explained real-world cases of music plagiarism such as that of George Harrison, by adapting the three-stage paradigm for use with a musical task.

**Dissociation of factors affecting recall-own and generate-new plagiarism**

Three types of error may occur within the Brown and Murphy (1989) paradigm, two in the recall-own task, and one when generating new ideas. In the recall-own task, participants may either recall another participants idea as their own, or give away their own ideas, claiming that they were generated by others (Perfect & Stark, 2008a). In this phase, source monitoring processes are involved as participants must first determine that an idea being recalled was created during the generation phase, and then determine whether the source of the idea was themselves or another participant. Manipulations designed to increase similarity of source traces, by assigning participants to work in same-sex dyads (Macrae et al., 1999), monitoring (Landau & Marsh, 1997) or elaborating over others' ideas (Stark et al., 2005), therefore inflate source confusion (in plagiarism as well as giving away ideas) only in the recall-own task.

Generate-new plagiarism differs slightly in that it involves generating an idea with the belief that it is original when it was previously-encountered, regardless of the original source. When completing a generate-new task, the only decision to be made is whether the idea is sufficiently familiar to be rejected as old; source monitoring for own versus others ideas is not involved (Stark et al., 2005). It is therefore not surprising that manipulations designed to inflate errors in source monitoring (e.g., elaboration, or working in same-sex dyads) do not affect generate-new plagiarism (Macrae et al., 1999; Perfect et al., 2009; Perfect & Stark, 2008b; Stark & Perfect, 2006, 2008; Stark et al., 2005). While more is known about recall-own plagiarism from recent experiments, understanding generate-new plagiarism is particularly important for musicians, as real-world music composition involves both own-other source monitoring and old-new decisions (Perfect & Stark, 2008a).

In verbal creative tasks, generate-new errors were increased when participants believed the idea to have greater value. Bink et al. (1999) found that, when generating new solutions to reduce the incidence of traffic accidents, participants were more likely to plagiarize from a credible source (traffic planners) than from college freshmen. Perfect and Stark (2008b) found that when ideas were randomly classified as excellent, very good, good, or satisfactory, participants were most likely to plagiarize the higher-rated ideas and least likely to plagiarize satisfactory ideas. In another experiment, Perfect and colleagues (2009) asked participants to complete the three-stage paradigm, incorporating the manipulations of elaboration after the generation phase, together with a confederate who they were informed was an expert in a particular domain (health or the environment). Similar to Bink and colleagues' (1999) findings, participants were more likely to plagiarize ideas from their partner in the generate-new task when these were from the confederate's domain of expertise. In addition, factors affecting recall-own and generate-new plagiarism were confirmed to be dissociated, as recall-own plagiarism was increased by idea improvement, but not by partner expertise. For generate-new plagiarism the reverse was true; while partner expertise increased plagiarism, idea elaboration had no effect (Perfect et al., 2009).

In addition to the source-monitoring explanation of recall-own versus generate-new plagiarism, Marsh and Bower (1993)'s model also offers a potential explanation for the dissociation between recall-own and generate-new plagiarism in the relative strength of activation of ideas in memory. The placement of the threshold between others' and own items ($T_{COMPUTER}$) determines plagiarism in the recall-own phase, where other's ideas are sufficiently strong in memory to be mistaken as one's own (Perfect & Stark, 2008a). In the generate-new phase, however, the threshold between others' and new items ($T_{NEW}$) defines the criteria by which a participant determines whether an idea is old or new. When the strength of own- and other-generated items decays in memory sufficiently, these items may be mistaken as novel ideas. Consistent with the predictions of the source monitoring framework (Johnson et al., 1993), source confusion and thus plagiarism therefore may involve both the quality of traces associated with memories, as well as the decision criteria involved in determining the source of an idea.

**The role of domain-relevant expertise**

The phenomenon of expert memory is widely known since Chase and Simon (1973)'s studies of expert memory for chess moves. Expert musicians are frequently shamed for plagiarizing, as it is assumed that an expert should be better able to discriminate others' ideas from their own (Macrae et al., 1999). Negative press coverage of plagiarism cases can adversely affect a performer's reputation

(Associated Press, 2015), often perpetuating the myth that plagiarism is always conscious and deliberate through the use of loaded emotive descriptions such as “rip-off”, and “thieves, liars, and cheats” (Ugwu, 2015). We therefore considered it important to test empirically whether participants’ domain-relevant expertise affects plagiarism.

In Bink and colleagues’ (1999) and Perfect and colleagues’ (2009) studies, the expertise of the source of an idea was manipulated. Given that three-stage paradigm studies have existed in the literature for over twenty years, it is surprising that the role of expertise of the recipient (i.e. domain-relevant expertise of the participant) in plagiarism has not yet been investigated using this paradigm. Dow (2015) found that Masters’ level scientists and engineers plagiarized less than undergraduates from examples provided in a divergent thinking design task. This would suggest that experts should plagiarize less than non-experts in a three-stage paradigm study, however, this cannot be assumed, as findings regarding the role of expertise in the broader literature of false memory are mixed.

Domain-relevant expertise leads to improved memory through improved organizational processing (Hunt & Rawson, 2011). New information is better integrated into existing schemata, leading to faster activation and retrieval (Castel, McCabe, Roediger, & Heitman, 2007). However, these same improvements to organization and retrieval of ideas also lead to an increase in intrusions in DRM paradigm studies when the items studied are within the participant’s domain of expertise. This is due to improved spreading of activation through a larger network of previously-experienced ideas (Castel et al., 2007). Individuals with highly superior autobiographical memory have also been found to experience increased false memory for autobiographical information in misinformation tasks (Patihis et al., 2013).

This suggests that the relationship between expertise, memory, and source monitoring is not as clear-cut as it may seem. According to Deffenbacher (1980)'s *optimality hypothesis*, greater optimality in information-processing conditions during storage and retrieval should improve metacognition as well as memory performance (Bothwell, Brigham, & Deffenbacher, 1987; Deffenbacher, 1980). Given that expertise improves organization, storage and retrieval from semantic networks (Hunt & Rawson, 2011; Rawson & van Overschelde, 2008) these optimized conditions should facilitate stronger memories but also better metacognition, because the quality of memories on which judgments are made is improved. Thus, it would be expected that experts should show improved source monitoring in comparison to non-experts. However, the inconsistencies in expert source monitoring reflected in the comparison of Dow (2015)'s and Patihis and colleagues' (2013) findings are also observed in other types of metacognitive judgement. Löffler, von der Linden, and Schneider (2016) studied confidence judgments, judgments of learning, and ease-of-learning in experts and novices, finding that while domain-relevant expertise may improve monitoring in some situations, expert knowledge may also increase optimism when assessing one's own performance, leading to increased use of familiarity heuristics and thus reduced monitoring accuracy. Expertise therefore appears to have separate effects on cognitive and metacognitive performance (Löffler et al., 2016).

Expertise has been defined by Ericsson, Krampe, and Tesch-Romer (1993) as being attained following a minimum of ten years of deliberate practice. Although this figure remains under debate, and deliberate practice is not the only factor involved in the acquisition of domain-relevant expertise (Ericsson, 2014; Hambrick et al., 2014), we considered this figure to be a useful benchmark for recruiting a sample of expert musicians. In Study 3, we aimed to test, in a sample of expert and non-expert musicians, whether participant expertise influences plagiarism. Based on the literature of domain-relevant expert memory (Bailes, 2010; Chase & Simon, 1973; Hunt & Rawson, 2011), together with Dow (2015)'s findings, and the optimality hypothesis (Bothwell et al., 1987; Deffenbacher, 1980), we expected that experts should show improved source monitoring, and thus plagiarize less than non-experts. However, if domain-relevant expertise were to increase, rather than decrease plagiarism, this might offer an explanation for the large number of court cases involving expert musicians which have attracted recent media attention (USC Gould School of Law, 2012).

**Measuring plagiarism in music**

The basic three-stage paradigm may be adapted for use with any creative task or domain. In verbal studies, category exemplars (Brown & Murphy, 1989; Macrae et al., 1999), computer-based word puzzles (Marsh & Bower, 1993), solutions to health and environmental problems (Perfect et al., 2009), and most commonly, the Alternate Uses task (Stark & Perfect, 2006, 2007; Stark et al., 2005) have been used.

In music, the simplest method of idea generation would be to compose a brief melody. To adapt the three-stage paradigm for music, we therefore asked participants to compose eight-note melodies, working with a computer partner instead of a live group. The length of melodies was chosen so as to provide sufficient information for the melody to be distinctive and recognizable (Bailes, 2010; Dalla Bella, Peretz, & Aronoff, 2003) yet brief enough to be held in working memory (Miller, 1956), particularly when working with untrained musicians. A further issue when designing a paradigm to study unconscious plagiarism is the potential for independent reproduction of ideas, given limited material (Frieler & Riedemann, 2011). This was avoided by allowing the melody to begin and end on any note of the scale, resulting in a possible $8^8$ = 16.7 million eight-note melodies which can be generated using an eight-note scale.

We based our investigation of the three-stage paradigm in music on the current findings in verbal studies, with the aim of testing whether these findings explain plagiarism in music, as proposed by Perfect and Stark (2008a). For this reason, we used the Brown and Murphy (1989) three-stage paradigm together with the manipulations of elaboration developed by Stark and colleagues (2005) to test for the effects of idea improvement and imagery on plagiarism. To keep the design simple, we examined the effects of elaboration in both the recall-own and generate-new phases, as we expected to observe a dissociation between factors increasing recall-own and generate-new plagiarism (Stark & Perfect, 2006, 2008; Stark et al., 2005), We also added a recognition test, following Stark and Perfect (2007), with the expectation that the same factors which increased recall-own plagiarism should also increase source confusion at recognition. As Experiment 1 of Study 3 was the first test of unconscious plagiarism using a musical task, to verify the accuracy of participant responses, we asked participants to complete all three tests of unconscious plagiarism (recall-own, generate-new and recognition) within the same experiment, because recognition is easier to test in music than recall (Müllensiefen & Wiggins, 2011). Indeed, we observed that participants found recalling six newly-composed melodies too difficult, and so in Experiment 2 of Study 3 as well as Study 4 we removed this task, and continued to use the generate-new and recognition tasks to test for unconscious plagiarism.

One problem encountered when measuring plagiarism in melodies, as opposed to verbal stimuli, is that verbal plagiarism can only ever involve absolute reproduction of the whole idea (Stark et al., 2005). Musical copyright cases, however, frequently involve partial or altered copying of an idea (Cason & Müllensiefen, 2012). Copying in music does not only involve reproducing some or all of the notes of a melody; harmony, rhythm and contour also contribute to the perception of musical similarity (Wolf & Müllensiefen, 2011). Copyright law in the United States, United Kingdom and Australia is therefore based on the *substantial part doctrine*, where the court must determine whether the similarity between the defendant's and plaintiff's works is substantial enough to constitute infringement (Australian Government Attorney-General's Department, 2012).

Computer-based modelling has been used to develop models of court decisions involving musical similarity. Müllensiefen and Frieler (2007) used a combination of algorithms including edit distance, rhythmic weighting, harmonic similarity and n-gram measures to measure similarity in pitch, implicit harmony, contour and rhythm of Western popular songs. Edit distance is a calculation of the minimum number of operations required to transform one string into another (Müllensiefen & Pendzich, 2009). Rhythmic weighting is used to assign durations to pitches in a melody so that these may be included in algorithmic calculations. N-gram algorithms compare substrings, or *n*-grams, where *n* denotes the number of elements in the substring (Müllensiefen & Frieler, 2006b). The harmonic similarity measures included in SIMILE are derived from the Krumhansl-Schmuckler algorithm (Krumhansl, 1990), which calculates the degree to which the distribution of pitches in a melody correlate with the 24 Krumhansl-Kessler (1982) key profiles, which represent the ideal distribution of pitches for each of the Western musical scales (Temperley, 1999). Although SIMILE can only analyze monophonic melodies, the implied harmonic and rhythmic structure, and contour of a melody also contribute to perceptions of similarity between two monophonic melodies (Wolf & Müllensiefen, 2011).

A regression model was used to build weighted combinations of these algorithms which model decisions of similarity made by expert musicologists. These algorithms, along with the optimized weighted combination measures were incorporated into their computer application SIMILE (Müllensiefen & Frieler, 2006a). For the present research, we selected the combination measure *opti3*, as it is designed to measure the similarity of melodies within a large corpus (Müllensiefen & Frieler, 2006b). This measure combines an *n*-gram measure of melodic similarity with harmonic edit distance and rhythmic measures.

Such methods have also been used to measure musical recall. In a reanalysis of Sloboda and Parker (1985)'s seminal investigation of melodic recall, Müllensiefen and Wiggins (2011) used computational analysis to determine the degree of similarity between participants' recall attempts and the original stimulus melody. We therefore chose to use SIMILE (Müllensiefen & Frieler, 2006a) to measure both correct recall and unconscious plagiarism by comparing melodies from the recall-own and generate-new phases with participant and computer-generated melodies from the generation phase.

## The present study and overview of the thesis

In this dissertation, we present two studies testing the computer-based method which we developed to examine unconscious plagiarism in music, together with two studies investigating the cognitive mechanisms associated with unconscious plagiarism in music.

An additional problem which we faced in developing an adaptation of the paradigm for music was the need for a computer-based method for testing, given that group generation of melodies would be noisy, and would introduce additional variables if participants were to perform on their own instruments. To ensure that we could control the number of times a participant was exposed to a given melody within the laboratory, and that the computer-generated melodies were not similar to other melodies that a participant may have heard prior to the experiment, we also required a set of original stimuli for use as the computer partner's compositions. In Study 1 we describe the development and testing of a computer-based toolkit for studies of memory for melody, and in Study 2 we examine one particular feature of the stimulus set – distinctiveness – which is important to the study of recognition memory.

Having established the validity of the toolkit and its accompanying stimulus set, Studies 3 and 4 examine the cognitive mechanisms involved in the unconscious plagiarism of musical ideas. We compare findings in music with the literature of unconscious plagiarism in verbal tasks, to examine the mechanisms involved in unconscious plagiarism across domains.

Some aspects of the thesis differ between chapters (e.g., reporting of statistics, justification of sample sizes) due to the requirements of the different journals to which these studies were submitted.

**Study 1 (Chapter 2)**

**Measuring responses in music: The MUSOS (MUsic SOftware System) Toolkit: A computer-based, open source application for testing memory for melodies**

**Aim.** To improve ease of administration and accuracy of measurement in music cognition studies through development of a computer-based framework for common paradigms of memory for melody. To improve accuracy in testing recognition by controlling the degree to which all participants are exposed to melodic stimuli, through the creation of a novel stimulus set, using a non-Western scale, which would be unlikely to trigger memory for melodies which participants had encountered outside of the laboratory.

**Summary.** Computer-based analysis has improved the understanding of participant responses in music (Müllensiefen & Wiggins, 2011). In Study 1, we tested a method for further improving experimental control in music cognition studies through computer-based test administration. We describe a computer-based method for generating and measuring recall and recognition memory for melodies. This computer program is built in a modular format, and may be configured to test explicit and implicit memory for melodies, stem completion, and musical recall. The application is accompanied by a set of 156 originally composed stimuli, composed on a non-Western scale, which were measured for properties involved in memory for melody using the software FANTASTIC (Müllensiefen, 2009a). A novel stimulus set allows the experimenter to control the degree to which participants are exposed to a given melody. Composition of these stimuli using a non-western scale avoids the possibility that a melody may trigger memory for other, similar melodies known to the participant, thus reducing experimental control (Sloboda & Parker, 1985). A group of pilot testers also rated the stimuli for perceived values of distinctiveness and valence, variables which are also associated with improved memory for music (Bailes, 2010; Schmuckler, 1997; Stalinski & Schellenberg, 2013). We show that specific features of the melodies are associated with human ratings of distinctiveness and valence. Increased variance in pitch and intervallic content, increased variation in contour, and ambiguity in tonality correlated with participant ratings of distinctiveness. In contrast, participant ratings of valence correlated with a more restricted intervallic range, but a wider modal interval, and closer correlations with a single Western musical scale.

We conducted a further pilot test in a separate sample of 26 participants to establish a group of 40 hard- and 40 easy-to-remember melodies, which are shown to differ on the properties measured. We show that the hard- and easy-to-remember melody sets differ based on the melodic features associated with distinctiveness, and that participants showed improved recognition performance for easy-to-remember melodies, in comparison to the hard melodies. The program and stimulus set therefore allows researchers without specialist musical training to conduct studies investigating memory for music in the general population.

**Study 2 (Chapter 3)**

**The distinctiveness effect in the recognition of musical melodies**

**Aim.** To test whether the distinctiveness effect in recognition memory, as found across domains, generalizes to memory for whole melodies.

**Summary.** In Study 2 we used the computer program and stimulus set from Study 1 to investigate whether the distinctiveness effect generalizes to memory for melody. Across domains, distinctive stimuli are better remembered than those which are more prototypical (Schacter & Wiseman, 2006). In music, distinctiveness has been identified as a factor facilitating specific aspects of musical recognition, including the identification of probe tones within a melody (Vuvan, Podolak, & Schmuckler, 2014), the point of recognition at which a listener can identify a melody (Bailes, 2010), and the improved recognition of melodic in comparison to rhythmic material (Hébert & Peretz, 1997). Surprisingly, no studies have yet tested the effect of distinctiveness when recognizing whole melodies. In Study 2, we tested for this effect using the computer program developed in Study 1, together with a subset of the stimulus set containing the 48 most and least distinctive melodies, according to participant ratings. As for Study 1, we use FANTASTIC (Müllensiefen, 2009a) to demonstrate the classification of these stimuli according to musical features associated with distinctiveness. We show that participants' ability to distinguish between studied and unstudied melodies was greater for high- than low-distinctiveness melodies. This advantage was due to more hits (correct recognition of studied melodies) for the high-distinctiveness melodies, rather than fewer false alarms for these melodies. This indicates that the distinctiveness effect, as observed in other domains, extends to memory for whole melodies.

**Study 3 (Chapter 4)**

**Blurred lines: Why music composition is highly susceptible to unconscious plagiarism**

**Aims.** 1) To identify the cognitive mechanisms associated with unconscious plagiarism in music: Are these the same as for verbal creative tasks? 2) To investigate whether domain-specific expert memory influences plagiarism of music.

**Summary.** To investigate the first of these two research questions, in Study 3 we used a configuration of the program developed in Studies 1 and 2 to present our adaptation of the three-stage paradigm for use with melodic stimuli. Study 3 presents two experiments investigating unconscious plagiarism in music. Experiment 1 of the study is a publication of the initial findings from the candidate's Honours thesis (Rainsford, 2013), and Experiment 2 was conducted during PhD candidature as a large scale replication and extension of the initial findings. To test whether the factors that influence verbal unconscious plagiarism generalize to music, in both experiments we asked participants to elaborate melodies using improvement and imagery (Stark et al., 2005).

Our second research question was whether domain-relevant expertise influences plagiarism. Using Ericsson and colleagues' (1993) definition of expertise as being acquired following a minimum of ten years' intensive study, in both experiments we compared the results of a group of expert and non-expert musicians. While expertise improves memory for domain-relevant items (Chase & Simon, 1973; Hunt & Rawson, 2011; Rawson & van Overschelde, 2008; Van Overschelde, Rawson, Dunlosky, & Hunt, 2005), as expertise can also increase false memory (Castel et al., 2007; Patihis et al., 2013) we made no particular predictions regarding the role of musical expertise in plagiarism.

Contrary to expectations, all forms of elaboration increased unconscious plagiarism in comparison to control melodies, both when generating new melodies, and when recognizing melodies. Participants also indicated significantly greater familiarity with melodies following elaboration. Thus, we show that unconscious plagiarism in music is facilitated by re-exposure, regardless of the task involved. In both experiments, we found no evidence to support an effect of expert memory on plagiarism; experts were as susceptible to plagiarism as non-experts.

The results are considered in context of the literature of implicit and explicit memory. Explicit memory is facilitated by elaboration, whereas implicit memory is facilitated by priming (Schacter & Church, 1992; Schacter & McGlynn, 1989). Musical knowledge is predominantly acquired implicitly through exposure (Rohrmeier & Rebuschat, 2012). According to the source-monitoring framework, where implicit memory is employed, source-monitoring processes may not be engaged (Johnson et al., 1993). Thus, we show that the dissociation between implicit and explicit memory systems extends to the mechanisms which facilitate unconscious plagiarism across domains.

**Study 4 (Chapter 5)**

**Unconscious plagiarism in music: Pilot testing an intervention to reduce plagiarism**

**Aim.** To investigate whether the risk of unconscious plagiarism in music can be reduced through listening to a musical cognitive distractor task.

**Summary.** In Study 3, contrary to expectations, we discovered that exposure increases plagiarism in music, regardless of the task involved. This suggests that the risk of unconscious plagiarism is far higher for musicians, as they cannot be expected to avoid exposure to music. From an ethical perspective, the most important follow-up study was to investigate a potential intervention aimed at reducing the risk of unconscious plagiarism in music.

Study 4 presents a pilot test of an intervention based on distractor tasks used in verbal recall studies. Glanzer and Cunitz (1966) found that recall for recently-studied words was impaired after the presentation of a distractor task. Petrusic and Jamieson (1978) further demonstrated that listening to vocal music was equally effective to a verbal distractor task in interfering with recent verbal recall. However, listening to instrumental music interfered with earlier rather than recently presented items. Recent research has found that a tonal loop, similar in function to the phonological loop, is used to rehearse musical information (Schulze, Zysset, Mueller, Friederici, & Koelsch, 2010; Williamson, Baddeley, & Hitch, 2010). Together, these findings would suggest that presentation of a melodic distractor task should interfere with memory for melodic information, thus reducing memory for items that might be candidates for plagiarism.

We tested the use of a musical distractor task, in the form of randomly generated musical notes, during the retention interval of the three-stage paradigm. We trialed the intervention using three between-subjects conditions, a) at the end of the first session of testing, after idea generation and elaboration, b) at the beginning of the second session of testing, prior to the generate-new phase and the recognition test, and c) a control group received no intervention, and completed the paradigm in the same format as Study 3. We included the manipulations of elaboration as used in Study 3, to test whether the intervention had different effects after idea improvement and imagery.

We observed atypical patterns of unconscious plagiarism in both the generate-new task and the recognition task in comparison to Study 3. However, we found no evidence to support an effect of the intervention in either task. Although this may have been due to the small sample size in this pilot study, we also observed that the intervention failed to affect strength in memory for the melodies. Participant familiarity ratings showed the same pattern as for Study 3, with elaboration increasing familiarity for melodies in comparison to control. Thus, the distractor task may have been too brief, or alternately, consolidation of memory for melodies may already be strong after idea generation and elaboration has taken place (Stark & Perfect, 2008; Stark et al., 2005). Further research is therefore needed to develop an effective intervention which targets musical plagiarism, as unconscious plagiarism in music proves extremely difficult to avoid.

## Chapter 2: Study 1

## The MUSOS (MUsic SOftware System) Toolkit: A computer-based, open source application for testing memory for melodies[§]

Rainsford, M., Palmer, M. A., & Paine, G. (2017) The MUSOS (MUsic SOftware System) Toolkit: A computer-based, open source application for testing memory for musical melodies. *Behavior Research Methods*, Online First publication. doi: 10.3758/s13428-017-0894-6 [§]

**Abstract**

Despite numerous innovative studies, rates of replication in the field of music psychology are extremely low (Frieler et al., 2013). Two key methodological challenges affecting researchers wishing to administer and reproduce studies in music cognition are the difficulty of measuring musical responses, particularly when conducting free recall studies, and access to a reliable set of novel stimuli unrestricted by copyright or licensing issues. In this paper, we propose a solution for these challenges in computer-based administration. We present a computer-based application for testing memory for musical melodies. Created using the software Max/MSP (Cycling ’74, 2014a) the MUSOS (MUsic SOftware System) Toolkit uses a simple modular framework configurable for testing common paradigms such as recall, old-new recognition and stem completion. The program is accompanied by a stimulus set of 156 novel copyright-free melodies, in audio and Max/MSP file formats. Two pilot tests were conducted in order to establish properties of the accompanying stimulus set relevant to music cognition and general memory research. By using this software, a researcher without specialist musical training may administer and accurately measure responses from common paradigms used in the study of memory for music.

**Keywords:** music cognition, software, replication, memory, recognition

Music psychology is an emerging field of research which has contributed numerous theoretical models to the literature describing the ways in which musical elements such as pitch, melody, and harmony are perceived, processed, and remembered (Deutsch, 1982; Krumhansl, 1991; Snyder, 2000, 2009). Insights gained from research into the cognition of music have also contributed to our understanding of general cognitive processes. The study of memory for musical melodies has yielded insights into the way in which auditory material is perceived and encoded, leading to an improved understanding of working memory processes (Berz, 1995; Williamson et al., 2010), and the identification of differences between verbal and musical semantic memory (Schulkind, 2004). However, despite considerable growth in the music psychology literature over the last 30 years, independent evidence confirming the reproducibility of findings is lacking (Frieler et al., 2013). As in general psychology (Open Science Collaboration, 2015), there is a pressing need to facilitate replication studies in music cognition. According to a recent review by Frieler and colleagues (2013) the percentage of exact replication studies and meta-analyses published in four major music psychology journals is around 1%, with only 10 meta-analyses and 18 replication papers identified overall. In music cognition, the difficulty of developing and administering accurate measures of participant response further compounds the task of replicating previous findings. Considerable advances have been made in the measurement and understanding of participant responses through computer-based analysis (Müllensiefen & Wiggins, 2011). In this article, we present a computer-based toolkit designed to help researchers overcome two key problems faced when designing and replicating music cognition studies: measurement of recall responses and the availability of novel stimuli.

The first problem concerns measuring and interpreting participants' responses in studies of music and memory. Fewer studies have been undertaken of musical recall than recognition (Müllensiefen & Wiggins, 2011), as challenges are presented in recording and interpreting an accurate response from untrained musicians (Sloboda & Parker, 1985). Where test administration involves musical performance at a keyboard, or the interpretation of sung responses from a participant (e.g., Bailes, 2010; Warker & Halpern, 2005), a researcher with skilled musical training is required, further limiting the replicability of studies.

Computer based data analysis has facilitated improvements in the interpretation of musical data, allowing participant responses to be interpreted objectively and with greater accuracy (Müllensiefen & Wiggins, 2011). A computer-based method for testing paradigms of musical recognition and recall would ensure that a participant's true response is being measured, whilst reducing reliance on trained musicians as researchers.

We present a computer-based method for testing memory for musical melodies. Designed in Max/MSP 6.1 (Cycling '74, 2014a), the MUSOS (MUsic SOftware System) Toolkit is compatible with computers running Windows XP and above, and Mac OS X 10.5 and above. The application consists of a framework housing several modules which may be configured to administer standard paradigms used in memory research including recall, explicit recognition, and implicit memory studies including stem completion. The program is open source, released under the Gnu General Public License (GPL) 3.0 (Free Software Foundation, 2007), with documentation provided on configuring the modules provided to create tests of different types and stimulus length. The toolkit, including all source files, documentation, and sample data, is available for download at http://www.soundinmind.net/MUSOS/MUSOS.zip. An experienced Max/MSP programmer is welcome to download and customize the program according to their needs.

The second problem faced by researchers in music cognition concerns the availability of novel musical stimuli. In general, studies of musical memory have used databases of folk songs (e.g., Bailes, 2010; Schmuckler, 1997), which are out of copyright, but present the possibility that an unknown folk melody may trigger memory for other, similar folk songs (see Sloboda & Parker, 1985, p. 159). Alternatively, databases of popular songs already known to the participant have been used to test on-line recognition and absolute pitch memory (e.g., Jakubowski & Mullensiefen, 2013; Levitin, 1994; Schulkind, 2004). While database sources are commonly used as an accessible means to prepare stimuli, the researcher may wish to control the degree to which participants are exposed to the melodies, rather than relying on exposure via popular media or other external sources. A novel set of 156 copyright-free melodic stimuli is therefore provided with the MUSOS Toolkit, comprising a set of 78 eight-note and a set of 78 sixteen-note melodies. All melodies are composed on a non-Western modal scale, so as to reduce the possibility that sources outside of the laboratory are triggered in memory. The stimuli were analyzed using the application FANTASTIC (Müllensiefen, 2009a) for properties important in the study of music cognition, including pitch, intervallic and contour features. The stimuli were also rated by a group of pilot testers for values of distinctiveness and valence, variables that have been found to be associated with improved memory for musical items (Bailes, 2010; Stalinski & Schellenberg, 2013). The stimulus set is released under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International license (Creative Commons, 2013), thus no copyright issues are presented for researchers wishing to use these melodies in testing, or to reproduce examples in a journal article. The stimuli are supplied as both Max/MSP jit.cellblock text files and in .wav format, so that they may be imported into an existing software framework if preferred. The program may also be configured so that researchers may enter and save their own stimulus sets.

In this paper, we first describe the rationale and design of the MUSOS software application and the tests for which it may be configured. We further describe the method used in constructing and testing the accompanying stimulus set. We present results from two pilot tests, the first conducted to obtain values describing features of the accompanying stimulus set important to studies of music and memory. The second pilot test was conducted in order to establish a subset of stimuli from the collection provided which were designed to be either very difficult, or very easy to remember. The data obtained in pilot testing thus enables researchers to use MUSOS and its accompanying stimulus set “out of the box” to set up studies.

**Understanding and measuring memory for musical stimuli**

In developing a stimulus set to accompany a toolkit for studies in music and memory, it is important to consider the ways in which musical information is perceived, stored and retrieved, and the factors that influence successful retrieval. We provide below a brief introduction to auditory memory and processing of the melodic features for which we provide measurement in the accompanying stimulus set, however, for a comprehensive introduction to the topic of music and memory we recommend the seminal works of Deutsch and colleagues (1982), Snyder (2000), and the Oxford Handbook (Hallam, Cross, & Thaut, 2009).

The current cognitive model of auditory memory ingrates Sperling (1960) and Darwin, Turvey, and Crowder’s (1972) concept of a brief sensory (echoic) memory store, with Baddeley and Hitch's (Baddeley, 2012; 1974) model describing the transfer of incoming perceptual information from sensory memory, to processing and rehearsal in working memory, and storage and retrieval from long-term memory. As for other domains, long-term memory may be implicit, without conscious awareness, or explicit (Schacter, 1987). Although memory for musical structures, like language, is stored in semantic memory, episodic memory is also involved in remembering experiences of music (Snyder, 2000).

Incoming auditory information from the environment is initially perceived by the nerve cells of the ear as a series of impulses representing frequencies and amplitudes. Auditory information is then stored in echoic memory as a very brief sensory image, lasting only a few seconds (Darwin et al., 1972; Snyder, 2009). At this stage, features occurring simultaneously or close together are extracted from the incoming information stream by higher level neurons and bound into units so that they may be perceived *categorically* as separate pitches, and interval relationships between pitches (Aruffo, Goldstone, & Earn, 2014; Snyder, 2000). Categorical perception of pitch, interval distances, and basic rhythmic features is a *bottom-up* process where the information stream is grouped by the nervous system and perceived as events (Dowling, 1982; Snyder, 2000). Larger level groupings occur as information is passed from echoic to working memory; events occurring sequentially are bound together and perceived as rhythmic patterns, or brief melodic phrases. The process of feature extraction and categorical perception may at the same time trigger recognition, through activation of previously stored experiences in long-term memory (Snyder, 2000).

Working memory is limited in capacity, and can store approximately seven (plus or minus two) unique items (Miller, 1956). Information in working memory must be *rehearsed* in order to be stored in long-term memory (Baddeley & Hitch, 1974). The amount of information being manipulated in working memory may be increased through grouping or 'chunking' into repeated patterns. In music, this may involve repetition of sequences of notes and rhythmic patterns to build a complete phrase; the length of a musical phrase is often designed to be approximately the same duration as the capacity of working memory, on average around 4-8 seconds. Larger-scale groupings of phrases into formal musical structures are understood and stored in long-term memory (Snyder, 2000, 2009).

Working memory is currently understood to have at least four components, these being a *central executive*, which coordinates operations on information held in three buffers used to process different types of sensory material, the *visuo-spatial sketchpad*, the *phonological loop*, involved in the rehearsal and storage of verbal material, and the *episodic buffer*, which stores brief episodic experiences (Baddeley, 2012; Baddeley & Hitch, 1974). Verbal and auditory information are proposed to share use of the phonological loop, however, recent evidence also supports a separate store for musical pitch, as a *tonal loop* involved in the rehearsal of tonal information (Schulze et al., 2010; Williamson et al., 2010). Music, however, does not involve just a single store, but is a multisensory experience integrating auditory, episodic and visual processing (Williamson et al., 2010).

Grouping of information into chunks may occur either through bottom-up processing of information at the psychophysical level (Dowling, 1982), or through *top-down*, schema-driven processing (Snyder, 2009), where previous experiences define a set of schemata or higher-order abstractions, through which a listener may understand, recognise, or make predictions about a piece of music (Deutsch, 1999; Krumhansl, 1991). These may include information on pitch chroma hierarchies, tonality, contour, and rhythmic patterns, as well as relationships between these features (Snyder, 2009).

The processing of pitch material has most notably been investigated by Deutsch (1970, 1972, 1973, 1974, 1975) who proposed that neural pathways involved in the processing of musical pitch are organised hierarchically in a similar way to the perception of letters and words. Most musicians, unless they possess absolute pitch, recognise a melody from its *intervals*, or the distance in semitones between consecutive notes. Deutsch (1969) proposed that a lower-level neural system dedicated to the recognition of musical intervals in turn activates a higher-level organisation of neurons based around the musical scale, thus explaining the recognition and storage of melodies in terms of their intervallic structure and relationship to musical scale.

While basic pitch and interval distance perception involves bottom-up processes at the psychophysical level (Deutsch, 1999; Dowling, 1982), Deutsch (1972) obtained evidence that, similar to verbal information, interval perception is also informed by top-down processes. When a well-known folk melody was presented to participants with the octave placement of its notes randomly varied, or with pitch information removed, listeners were unable to recognise the melody. However, when the name of the tune was provided, listeners were able to follow the melody, by matching the perceived tones against their expectations of intervallic relationships (Deutsch, 1999).

Krumhansl (1991; Krumhansl & Kessler, 1982) further demonstrated schema-based processing of hierarchical relationships between the notes of the scale, or pitch chroma, as certain notes are perceived as closer or more distant to the root note of the scale or *tonic*. Schemata defining these relationships are acquired implicitly from music-listening, and vary according to the listener's exposure to cultural musical traditions (Stevens & Byron, 2009). In Western music, notes of the scale close to the tonal centre, and intervals based on close relationships to the tonic (e.g., perfect fourth and fifth) are more predictable (Bailes, 2010). Following from this, melodies that are more *tonal*, i.e. whose content is built around such strong relationships to the tonic, are more expectable, and thus better remembered (Deutsch, 1980; Krumhansl, 1991; Schmuckler, 1997; Vuvan et al., 2014). Melodies containing such schema-congruent, or in musical-theoretical terms, tonal events are also perceived as more pleasurable (Huron, 2006). At the same time, Vuvan and colleagues (2014) found a U-shaped relationship to expectancy, such that a distinctiveness effect (Schacter & Wiseman, 2006) also occurs in memory for melodies. Both highly expected, and highly unexpected notes in relationship to the tonic facilitate improved memory.

In addition to scale and tonal relationships, the contour, or rise and fall of a melody, plays an important role in melodic recognition. White (1960) and later Dowling (1978; Dowling & Fujitani, 1971) demonstrated that melodies may be recognised by their contour even when individual notes are distorted. Melodies are also easier to discriminate when their contours are different, but discrimination between a standard and comparison melody is more difficult when a melody is subject to 'tonal transposition', where the contour is retained but the notes of the melody are shifted upwards along the same scale, altering its intervals slightly. From this evidence, Dowling (1978) proposed that musical contour is processed and stored independently from memory for pitch and interval sizes. Where the tonal context of a melody is ambiguous (e.g., in tonal transpositions, or atonal melodies) the listener relies upon contour to recognise melodies (Dowling, 1982). The ability to discriminate contour develops in infancy, along with the ability to reproduce pitch and understand basic rhythmic groupings, whereas discrimination of intervals and schema-based processing of tonality begins later in childhood, developing towards adulthood (Dowling, 1982).

Halpern (1984) discovered a similar hierarchy in the priority to which non-musicians and musicians process scale, contour and rhythmic content of melodies. When encountering novel music, melodies are initially discriminated based on their rhythmic content, followed by contour. For non-musicians, mode (whether the melody is written on a major or minor scale) is the least salient element, further demonstrating the importance of contour in melodic recognition, although mode was found to have greater importance to trained musicians.

It is therefore important that a researcher wishing to study music and memory has access to information describing the pitch and intervallic relationships, tonality, and contour of the stimuli which they will use, in order to determine which stimuli are likely to be perceived and remembered with greater or lesser ease. Various computational methods have been developed to measure these factors in melodies. In this study, we used Müllensiefen's (2009a) application FANTASTIC to measure the stimuli provided with the MUSOS Toolkit. This software is capable of producing descriptive statistics and measures of entropy describing the uncertainty or predictability of pitch content (tone chroma), intervallic content, and the degree to which the melody accords to major or minor scale tonality. Contour is described using Huron's (1996) eight[**] classifications, and Steinbeck's (1982) step contour and interpolation contour methods.

[**] Huron's (1996) classification system incorporates nine classes of contour.

**Paradigms used in the study of memory for music**

In selecting paradigms for inclusion in a toolkit designed to facilitate studies of music and memory, one must consider not only the applicability of the paradigms to be included and their relevance to the literature, but also the architecture and usability of the program. Scientific software is frequently developed by specialist end-users, restricting further development to the laboratory where the software was developed (Macaulay et al., 2009). Similarly, reliance on specialist knowledge can potentially restrict studies of music psychology to a single laboratory or group of researchers. If we aim to create tools that make administration and re-testing of studies easier for a non-specialist researcher, then the architecture of that software must be logically designed to facilitate ease of use (John & Bass, 2001).

While our aim in developing MUSOS was to encourage replication of studies, an attempt to reproduce every paradigm used in music psychology would be too broad a design, and would thus reduce ease of use of the program. In selecting candidate paradigms for inclusion, we therefore first considered theories of long-term memory, and the ways in which memory has been studied and tested in music psychology as well as across domains, in order to design a framework that was sufficiently flexible to contain a selection of useful paradigms for non-musician researchers seeking to administer and replicate their own and others' studies.

Dual process models propose that recognition memory has two components, recollection, where specific details of encountering an event or item may be retrieved, and familiarity, an awareness that one has encountered something before, but without the ability to retrieve further details (Jacoby, 1991; Yonelinas, 2002). Recognition may therefore be explicit, involving conscious recall of the event, or implicit, where an increased fluency or *priming* is demonstrated despite a lack of conscious awareness of retrieval (Schacter, 1987; Schacter & Church, 1992).

In memory studies, explicit retrieval is tested using two methods: recognition and recall (Schacter, 1987). Both methods involve presenting the participant with a list of items to study in an initial exposure phase. In recall studies, the participant is then asked to recall as many items as they can remember, in free or serial order. For a recognition study, the participant is presented with a combination of novel and earlier-presented items, and asked to identify those that they recognise from the exposure phase (Müllensiefen & Wiggins, 2011). Implicit memory studies differ from recognition studies in that the participant is not forewarned of the upcoming test during the exposure phase. Priming may be demonstrated experimentally in a variety of tasks such as word fragment and stem completion, lexical decision tasks, or picture completion (Schacter & Church, 1992).

The majority of paradigms testing both explicit and implicit memory (in general cognition studies as well as music) fall into a two or three-phase structure, where the initial phase provides exposure to stimuli, the final phase tests memory for these stimuli, either through re-presentation of stimuli in implicit or explicit recognition studies, or providing a facility for the input of recalled items in recall studies. Manipulation of one or more factors under investigation may occur within the exposure phase, or during a second phase prior to testing. In music cognition, this has involved rating qualitative aspects of a piece of music such as similarity, familiarity or liking (Peretz, Gaudreau, & Bonnel, 1998), applying tempo or instrumentation changes (Halpern & Mullensiefen, 2008), or repeated exposure (Schellenberg, Peretz, & Vieillard, 2008).

In music, explicit recognition is one of the most commonly used methods for studying memory for musical items, due to the high level of experimental control possible (Sloboda & Parker, 1985). Studies of explicit recognition in music have yielded findings that musical key, timbre, tempo, and rhythmic content affect recognition of a melody (Halpern & Mullensiefen, 2008; Hébert & Peretz, 1997; Schellenberg & Habashi, 2015), that liking improves memory for music (Schellenberg et al., 2008; Stalinski & Schellenberg, 2013), and that, as for other domains, distinctive content improves recognition (Bailes, 2010; Müllensiefen & Halpern, 2014; Schacter & Wiseman, 2006).

Although numerous studies of explicit recognition exist in the literature of music psychology (Müllensiefen & Wiggins, 2011), few studies of implicit memory for musical material have been conducted. One method developed by Warker and Halpern (2005) involved a musical adaptation of stem completion. In this study, following initial exposure, participants were presented with all but the final note of a group of previously heard and novel melodies, and were asked to complete the sequence by singing the most appropriate note to follow. This method differs from explicit recognition in that participants were not required to remember the note that followed, but were asked to judge which note would fit best musically (Warker & Halpern, 2005). Verification of the method as a test of implicit memory was demonstrated by Warker and Halpern (2005) using an encoding task to differentiate implicit memory for melodies, enhanced by shallow encoding of perceptual features, from explicit memory, which was found to be enhanced by deeper, semantic processing. Although promising, a search of the literature reveals that this method has not yet been replicated.

A further method used in the study of implicit memory for music involves exploiting the *mere exposure effect* (Zajonc, 1968), where liking for an item increases after exposure. This effect has been found to be particularly strong in music and may occur after a single re-exposure (Peretz et al., 1998), persisting for up to 24 hours (Stalinski & Schellenberg, 2013). The mere exposure effect has therefore increasingly been used as an index of implicit memory for music (Halpern & O'Connor, 2000; Peretz et al., 1998). Implicit memory for music is shown by increased pleasantness ratings at test for items heard at exposure, in comparison to novel items (Halpern & Mullensiefen, 2008). Müllensiefen and Halpern (2014) further used this method to identify a dissociation in qualities of melodies which lead to improved implicit and explicit recognition.

Recall studies present a particular difficulty for those studying musical memory, as it has proven difficult to measure recall performance in music. Traditional methods have required the participant to use musical notation or to perform their response on a musical instrument (Deutsch, 1980) or by singing (Sloboda & Parker, 1985; Warker & Halpern, 2005). Müllensiefen and Wiggins (2011) discuss in detail the challenges presented when attempting to analyse data from sung responses, which they describe as "dirty" as a researcher must frequently make subjective judgements as to which note a participant intended to sing. A participant may be capable of perceiving pitch correctly, yet unable to exercise sufficient motor control over their vocal apparatus to sing their response in tune (Hutchins, Larrouy-Maestri, & Peretz, 2014). Responses that are a few cents above or below the note may be normalised with electronic equipment (see Warker & Halpern, 2005), but a singer with poor pitch control may miss the intended pitch by several semitones, or transpose segments of the melody while retaining correct pitch interval relationships (Dalla Bella & Berkowska, 2009; Dalla Bella, Giguère, & Peretz, 2007). Despite potentially possessing normal pitch perception, singers with such difficulties in vocal control are often excluded from studies, or the sample restricted to those with musical training (e.g., Levitin, 1994; Warker & Halpern, 2005). While this may result in more reliable responses, this leaves researchers unable to investigate questions regarding untrained musicians, or to compare the effects of expert training in music with a control group. We provide with the MUSOS toolkit a computer-based method for participants to input recall responses, thus facilitating studies in untrained populations.

A further issue encountered by researchers wishing to study recall in music lies in the analysis of the data collected. Sung responses must be transcribed into musical or MIDI notation for analysis, requiring musical expertise on the part of the experimenter as well as participant (Müllensiefen & Wiggins, 2011). Unlike verbal recall, responses in the recall of musical melodies are rarely exact, and often involve partial recall of segments of the melodies, with errors or omissions of several notes. Scoring of musical recall data has therefore frequently involved subjective judgements as to how closely a response resembles the original (for an example see Sloboda & Parker, 1985, p. 157). Instead of using subjective musicological techniques in analysis, Müllensiefen and Wiggins (2011) recommend conducting the data analysis of such studies using computational tools capable of similarity analysis, such as the SIMILE toolkit (Müllensiefen & Frieler, 2006a), so that factors such as missing or distorted notes and transpositions may be taken into account. We therefore include with the MUSOS Toolkit a means of exporting recall data to CSV, along with a spreadsheet for analysis in Excel using the *edit distance*, or *Levenshtein distance* algorithm, a simple form of similarity analysis based on the number of edits needed to transform a participant's attempt into the original melody (Müllensiefen & Wiggins, 2011).

**Rationale, aim and scope of the present study**

Although a considerable number of innovative studies continue to be contributed to the literature on music and memory, as for other domains, it is of concern that few replication studies are undertaken of both novel and existing experiments (Frieler et al., 2013). One possible reason for the lack of replication studies in music psychology may lie in the difficulty of measuring participant responses (Müllensiefen & Wiggins, 2011). Our aim was therefore to facilitate ease of administration and measurement, and thereby improve the replication of studies by music researchers, by providing an easy to use toolkit which is capable of reproducing a number of common paradigms.

The three-phase structure of exposure, manipulation and testing phases is common to a number of important studies across both music and general cognition. It is ideal for the construction of a toolkit that is easy for researchers to use. In terms of software design, the three phases may be used as a framework, within which modules for each phase may be selected and added to form test paradigms. For example, if testing the effects of repeated exposure on implicit memory for melodies, a module for exposure, re-exposure, and a final test of pleasantness ratings would be used. For explicit recognition, the re-exposure module would be removed, and the final module would be reconfigured to test recognition of old and new items. Although there are a number of noteworthy paradigms which fall outside of this structure, it would not be possible to provide in a single program a means of replicating all past studies, nor would such a program be capable of being contained within a simple and thus usable architecture (John & Bass, 2001). Arguably many important studies which do not use a three-phase structure are already well replicated in the literature – for example, Deutsch's pitch comparison paradigm (Deutsch, 1970, 1972, 1973, 1974), Dowling's AB comparison method, used to present standard and comparison melodies for discrimination of changes in contour (Bartlett & Dowling, 1980; DeWitt & Crowder, 1986; Dowling, 1978; Dowling & Bartlett, 1981) and cohort theory studies[††] using dynamic melody recognition (Bailes, 2010; Dalla Bella et al., 2003; Schulkind, 2004). In contrast, relatively few studies have been undertaken of musical recall and implicit memory for music (Müllensiefen & Wiggins, 2011).

We therefore aimed to use the three-phase structure to construct a modular framework which may be used for the study of recollection memory in music, covering implicit and explicit recognition and recall studies, in order to make it easier for researchers with or without musical training to administer and reliably measure studies in the general population, thus facilitating increased replication of both past and future studies.

We further aimed to provide with this software a novel, copyright-free set of stimuli that have been designed and tested according to musical properties known to be involved in recollection memory. In developing the stimuli accompanying the MUSOS Toolkit we first used Bailes' (2010) measures of the likelihood of occurrence of notes of the musical scale as a rule to compose melodies that were more, or less distinctive in content, and thus, more or less likely to be well remembered. We then verified these melodies by obtaining ratings from a group of pilot testers on the perceived distinctiveness and valence of the melodies, as variables

[††] These studies use a gating paradigm to examine *cohort theory* in music recognition, the proposal that an initial melodic sequence activates a cohort of possible matches in memory which are progressively eliminated as the melody continues (Bailes, 2010).

associated with the likelihood of occurrence and memory for musical items (Bailes, 2010; Huron, 2006; Schmuckler, 1997).

We then used computer-based analysis to measure the properties of the full stimulus set, using FANTASTIC (Müllensiefen, 2009a) to compute data on pitch and intervallic predictability, tonality, and contour of the melodies. Within the stimulus set, we aimed to create two subsets of high and low difficulty melodies that researchers may use in testing. We selected those melodies which were highest and lowest in distinctiveness and valence, as rated by pilot testers, for use in a recognition study involving 26 participants. We further verified, using the data obtained from FANTASTIC that these subsets of melodies differ significantly in musical properties associated with the likelihood of remembering an item.

## MUSOS Software

**Software architecture and paradigm selection.** Our aim in designing this toolkit was to provide a platform which would assist researchers to generate and reproduce studies of music and memory, regardless of their level of musical training. By using the two or three-phase structure common to memory paradigms across domains within a visual development environment (Max/MSP; Cycling ’74, 2014a), we were able to construct a framework housing a system of modules that may be selected and inserted in a ‘plug and play’ fashion.

Our final selection of paradigms comprised explicit old/new recognition, implicit recognition (using the method described by Halpern and Mullensiefen (2008) as well as manipulation of the *mere exposure* effect (Zajonc, 1968)), stem completion (following the method described by Warker and Halpern (2005)), and free recall. To construct these paradigms, we provided five modules for exposure, rating of stimuli, recall, stem completion, and old-new recognition.

**Software design.** The main components of the MUSOS Toolkit are a Max/MSP *live.step* step-sequencer, used for the input and display of melodies, which is connected to a system of databases created from Max/MSP *jit.cellblock* objects. A step-sequencer is a device commonly used in popular electronic music production for the recording and automated playback of musical material. The sequencer *steps* through each division or beat of the musical bar, playing the note that is assigned to that beat (Aikin, 2014). In Max/MSP, the *live.step* object allows the user to interact with the sequencer via a grid interface, with notes represented as blocks within the grid. We chose this interface for use in MUSOS as it is intuitive to use, and does not require the participant or experimenter to be trained in reading a musical score. Each division of the X-axis of the grid represents a musical beat, with movement up and down the Y-axis representing increases and decreases in pitch, respectively (see Figure 2.1). Using this device, a melody may be represented as a series of coordinates (appearing as black blocks in Figure 2.1), and stored in numerical form in a database for later retrieval and analysis.

The use of a step-sequencer enables participants (and experimenters) to easily compose melodies by adjusting the location of blocks in the grid. In Max/MSP all musical cues including note names, tempo, and beat divisions may be removed from a step-sequencer (Cycling '74, 2014b), leaving a row of square blocks that the participant places into the desired position using the computer mouse. The participant does not need to be trained to identify notes on a chromatic keyboard, as the Y-axis of the device is pre-set to the pitches of the modal scale used in the stimulus set using MIDI quantization (see Figure 2.1). Advanced Max/MSP users may reconfigure the application to present custom scales using the documentation provided. This simple graphical interface is therefore easy for both trained musicians and untrained participants to use, and allows the variable of melody to be measured in isolation from rhythm, tempo, and timbre.

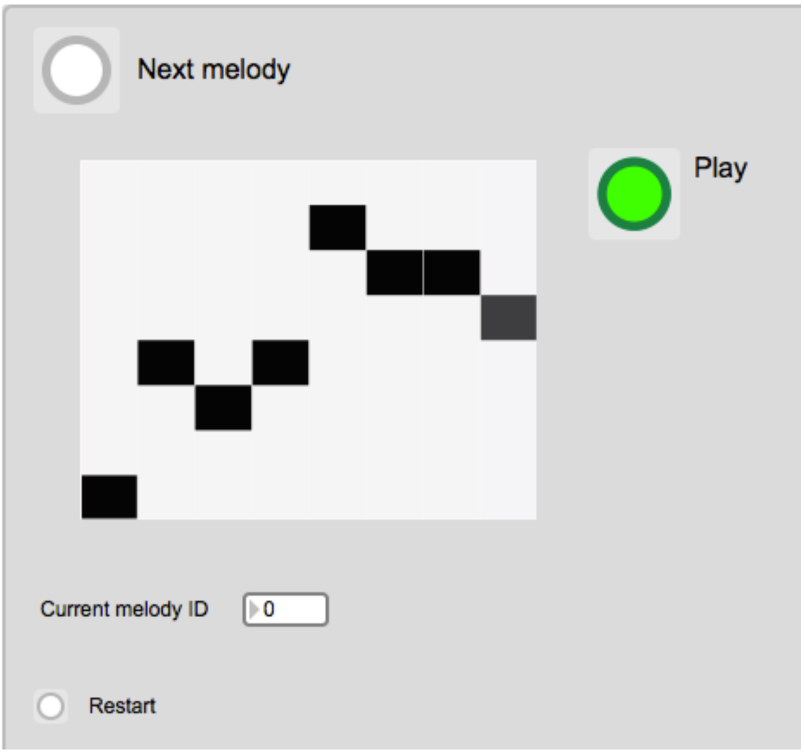


*Figure 2.1.* The step-sequencer device used in the application.All visual cues, including note names and beat divisions are removed, and the Y-axis of the device is pre-set to a MIDI-quantized modal scale.

**Modules included in the software.** Five modules are included with the MUSOS Toolkit. The *Exposure phase* module combines melodies from different conditions and displays these to the participant in random order. A *Rating* module allows participants to rate attributes of a selection of melodies (e.g., pleasantness, distinctiveness). Data from these ratings can be used for manipulation checks or correlational analyses (e.g., are melodies rated as more pleasant better remembered?), or for repeated exposure to stimuli. Alternatively, this module may be added to the final test phase in order to measure implicit memory for items. The remaining three modules supplied with the application are also designed for experimental testing following exposure; these include a *Free Recall*, *Stem Completion*, and *Recognition test* module.

Installation and connection of the modules to their databases is performed in Max/MSP Patching Mode. The experimenter then switches to Presentation Mode where the visual interface is displayed to the participant.

***Free recall.*** The graphical interface of MUSOS is designed so that the responses of those with and without specialist training may be reliably recorded. In the Free Recall module provided with the MUSOS Toolkit, the participant is presented with a series of blank step-sequencers into which they may input as many melodies from the exposure phase as they are able to recall. The step-sequencer device allows an untrained participant to use a simple graphical interface to enter, listen to, and correct their response, thus ensuring that the data recorded are as close as possible to the participant's true response. Responses do not require normalisation to the correct pitch, as the step-sequencer is pre-set to a MIDI-quantized scale. As the Free Recall module records melodies to a Max/MSP *jit.cellblock* database, it may also be used as a standalone module to record and save new stimuli for use in the program.

As interpretation of free recall data has also proven challenging for researchers (Müllensiefen & Wiggins, 2011; Sloboda & Parker, 1985), we provide with the MUSOS toolkit a method for computational analysis of free recall responses. As data in MUSOS is stored in numerical format, it may be exported to Comma Separated Values (CSV) format and converted for analysis with any suitable computational application. For researchers who are not familiar with such applications, we also provide an Excel spreadsheet for analysis of recall data in Excel using the *edit distance*, or *Levenshtein distance* algorithm, a simple form of similarity analysis based on the number of edits needed to transform a participant's attempt into the original melody (Müllensiefen & Wiggins, 2011). This method is capable of capturing subtle changes in response such as missing notes or transpositions of the melody without requiring subjective interpretation of the participant's intention.

An example of the output of Free Recall analysis can be seen in Figure 2.2. Participant responses are listed in column A, with original melodies in Column B. From Column D onwards, each participant entry is compared against the originals using the Levenshtein distance algorithm, which outputs values between 0 and 1, where 1 indicates a 100% match with the reference melody.

Unlike verbal studies, recall responses in music are rarely exact, a common finding when working with both trained and untrained musicians (Müllensiefen & Wiggins, 2011). When using an algorithmic measure of musical similarity, a threshold is normally set above which matches between two melodies are considered unlikely to occur beyond chance, and are thus considered significant (Müllensiefen & Frieler, 2007). For edit distance analysis, Müllensiefen and Pendzich (2009) used a threshold of 0.46, although values of up to 0.6 are commonly used (Frieler, email correspondence). On examination of the output of edit distance analysis, values below 0.5 indicated poor correspondence with the original (see Figure 2.2), and so for the supplied examples a threshold of 0.6 was therefore set as an indication of memory beyond chance for the original melody.

Further instructions for using the Free Recall analysis spreadsheets are provided in the MUSOS Toolkit Documentation.

F15 =Levenshtein3($A$4,B15)/100

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | RecallDB | ExposureDB | Melody ID | Attempt 1 | Attempt 2 | Attempt 3 |
| 2 | 65453342 | 47372737 | LD6 | 0 | 0.12 | 0.12 |
| 3 | 04162164 | 33435434 | HD3 | 0.38 | 0.12 | 0.75 |
| 4 | 33235433 | 57567023 | LD14 | 0.25 | 0.12 | 0.12 |
| 5 | 20264611 | 60642231 | HD1 | 0.25 | 0.12 | 0.12 |
| 6 | 45454322 | 20264611 | LD7 | 0 | 0.12 | 0.12 |
| 7 | 13634543 | 00102310 | HD14 | 0.12 | 0.38 | 0 |
| 8 | 01316340 | 24675310 | LD4 | 0.12 | 0.12 | 0.12 |
| 9 | 60642021 | 43543232 | HD4 | 0.38 | 0 | 0.38 |
| 10 | 01000110 | 13631454 | LD3 | 0.12 | 0.25 | 0.38 |
| 11 | 35534221 | 43233210 | HD2 | 0.12 | 0.12 | 0.38 |
| 12 | 33432100 | 01316340 | LD5 | 0.25 | 0.38 | 0.12 |
| 13 | 24334333 | 21202012 | HD8 | 0.12 | 0.12 | 0.12 |
| 14 | 47374727 | 65454342 | LD11 | 0.88 | 0 | 0.25 |
| 15 | 75576567 | 24334433 | HD10 | 0.25 | 0.12 | 0.5 |
| 16 | | 37534230 | LD15 | 0.25 | 0 | 0.38 |

D14 =Levenshtein3($A$2,B14)/100

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | RecallDB | ExposureDB | Melody ID | Attempt 1 | Attempt 2 | Attempt 3 |
| 2 | 65453342 | 47372737 | LD6 | 0 | 0.12 | 0.12 |
| 3 | 04162164 | 33435434 | HD3 | 0.38 | 0.12 | 0.75 |
| 4 | 33235433 | 57567023 | LD14 | 0.25 | 0.12 | 0.12 |
| 5 | 20264611 | 60642231 | HD1 | 0.25 | 0.12 | 0.12 |
| 6 | 45454322 | 20264611 | LD7 | 0 | 0.12 | 0.12 |
| 7 | 13634543 | 00102310 | HD14 | 0.12 | 0.38 | 0 |
| 8 | 01316340 | 24675310 | LD4 | 0.12 | 0.12 | 0.12 |
| 9 | 60642021 | 43543232 | HD4 | 0.38 | 0 | 0.38 |
| 10 | 01000110 | 13631454 | LD3 | 0.12 | 0.25 | 0.38 |
| 11 | 35534221 | 43233210 | HD2 | 0.12 | 0.12 | 0.38 |
| 12 | 33432100 | 01316340 | LD5 | 0.25 | 0.38 | 0.12 |
| 13 | 24334333 | 21202012 | HD8 | 0.12 | 0.12 | 0.12 |
| 14 | 47374727 | 65454342 | LD11 | 0.88 | 0 | 0.25 |
| 15 | 75576567 | 24334433 | HD10 | 0.25 | 0.12 | 0.5 |
| 16 | | 37534230 | LD15 | 0.25 | 0 | 0.38 |

*Figure 2.2.* Sample output from Free Recall data analysis using the Levenshtein distance algorithm. Melodies are aggregated into an eight-digit figure representing the eight degrees of the scale used in the melody. Each participant attempt in column A is compared against the original melodies in column B to produce a matrix. Significant responses (> 0.6) are highlighted in red. In the top panel, two melodies with a Levenshtein distance of 0.5 contain a range of notes in common, but are otherwise not audibly similar. In contrast, the lower panel shows two melodies that have a Levenshtein distance of 0.88, and are almost identical with the exception of the fifth note.

***Stem Completion.*** The Stem Completion module included with the MUSOS Toolkit is based on the method developed by Warker and Halpern (2005). Instead of requiring the participant to sing the most appropriate note to complete the melody, a computer-based interface is used. The module draws melodies from a task database which comprises a counterbalanced selection of items previously encountered in the Exposure phase alongside an equal number of novel melodies. The participant is presented with a step-sequencer containing all but the final note of a melody randomly selected from the task database. The participant first listens to the melody, and is then asked to select the note which would best follow by setting the final block in place. The result may be auditioned and corrected by the participant if necessary to ensure that the melody recorded reproduces their intended response (see Figure 2.3). Although the present method involves completion of a single note, the module may be easily adjusted following the documentation provided by those fluent in the use of Max/MSP so that stem completion of two or four notes may be tested. Scoring of a Stem Completion study is considerably simpler than scoring the Free Recall task, as the melodies completed by the participant must simply be exported to CSV format and compared to the original versions, which are stored by the program in a separate database. A matching final note is scored as a correct response, and all other responses are scored zero (Warker & Halpern, 2005). An Excel spreadsheet is also provided with the MUSOS Toolkit for scoring of Stem Completion data, along with sample data from an eight-note Stem Completion study.

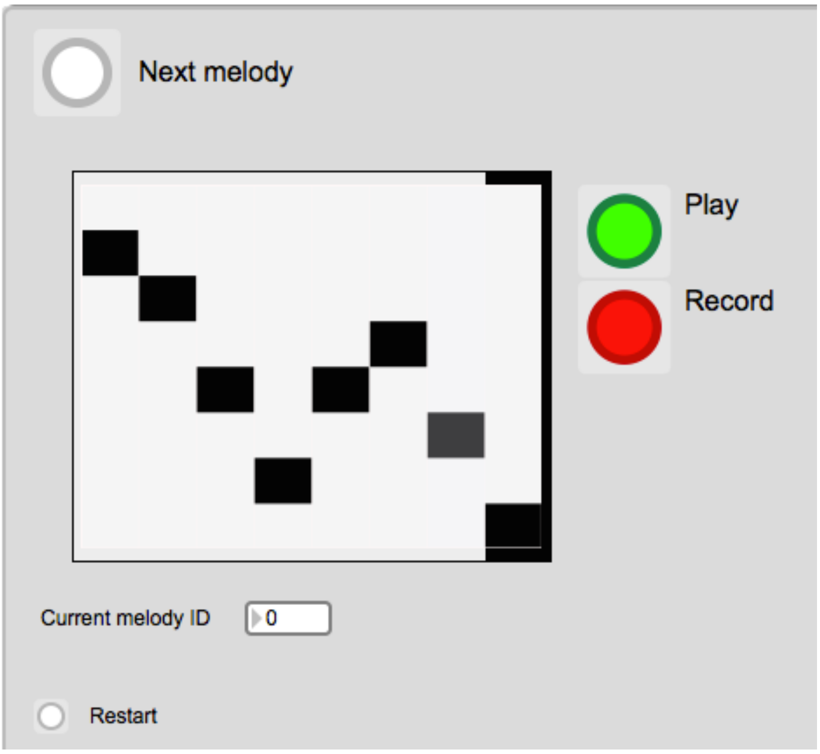


*Figure 2.3.* The Stem Completion module, based on the method developed by Warker and Halpern (2005). The participant is presented with all but the last note of the melody, and is asked to complete the melody with the most appropriate final note, by adjusting the block in the section outlined in black.

***Recognition.*** The Recognition module provided with MUSOS uses a simple list-wise recognition procedure, similar to those used in verbal and facial recognition studies (Müllensiefen & Wiggins, 2011). The module retrieves melodies in random order from the Recognition task database, again comprising an equal number of melodies previously encountered in the Exposure phase, counterbalanced with novel melodies. (When configuring the application to test both Stem Completion and Recognition, the Exposure phase melodies may be assigned in counterbalanced order to the two modules so that no duplicates occur). The Recognition module differs from the others as the step-sequencer interface is removed and replaced with a progress bar, in order to ensure that participants do not rely on the visual features of the sequencer for recall. Participants listen to each melody in turn, and use a dial-based control to input their response to the statement, “I heard this melody in the previous task”. Responses are recorded on a scale from +3 to -3, where +3 indicates “strongly agree”, 0 indicates neither agree or disagree, and -3 indicates “strongly disagree” (see Figure 2.4).

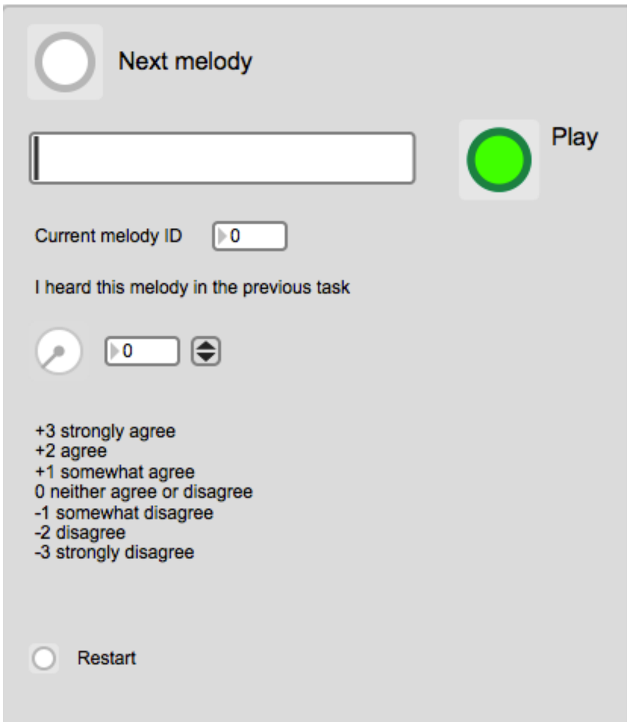


*Figure 2.4.* The Recognition module. The step-sequencer interface is removed and replaced with a progress bar. A dial is provided for participants to input the degree to which they recognize the item.

***Rating and the mere exposure effect***. The Rating module simply retrieves melodies from a task database and presents them to the participant alongside a dial based input for ratings using the same scale as used in the Recognition module. The basic module presents melodies using the step-sequencer. An alternate form of the

Rating module (*RecognitionImplicit)* is used for testing implicit memory via the *mere exposure effect* (Zajonc, 1968), where liking for an item increases after exposure (Peretz et al., 1998; Stalinski & Schellenberg, 2013). The *RecognitionImplicit* module uses the same progress bar as the Recognition module, to avoid visual recognition of melodies from the step-sequencer. As this method also requires a measurement of liking for melodies at initial exposure in order to detect increases in liking corresponding with repeated exposure, a modified form of the Exposure module, *Exposure-Rating*, is provided which incorporates the same rating mechanism on-screen.

Alternate configurations of the dial component of the Rating module are available to advanced Max/MSP users. Configuring the dial to a range of three steps instead of seven would make analysis of remember/know judgements (Tulving, 1985) possible, by instructing the participant to record a Remember judgement with a value of 0, Know with a value of 1, and Guess with a value of 2.

## Stimulus Development and Pilot Testing

The total stimulus set comprises 156 melodies, 78 of eight-note length and 78 of sixteen-note length. Below we describe the process of construction of the melodies. We then present the results of two pilot tests conducted to establish properties of the stimuli. The first provided data on the properties of each melody, including subjective ratings of distinctiveness and valence, and computational analysis of pitch, intervallic, tonal, and contour information using the software FANTASTIC (Müllensiefen, 2009a). The second test identified a subset of melodies that varied in musical properties affecting difficulty of recognition (i.e., one set of relatively difficult to recognize melodies and one set of easy to recognize melodies), which were then tested in a recognition study involving 26 participants.

**Stimulus properties**

**Scale.** In providing an original stimulus set, we aimed to ensure that the tonality of the melody was unfamiliar to Western listeners, thus minimizing the chances that a novel melody presented during an experiment will remind the listener of some other melody previously heard outside of the laboratory. The melodies were therefore composed using a seven-note scale commonly used in world music (*Maqam Kurd*, in Arabic music, also known as the *Phrygian mode* in Western medieval music, and as *Hanumatodi rāgam* in Carnatic music). This scale is structured around a semitone-tone-tone-tone pentachord followed by a semitone-tone-tone tetrachord (concluding on the upper octave), which differs in structure to both the Western major and minor scale (see Figure 2.5 for a comparison against these scales)[‡‡].

[‡‡] The purpose of creating a novel stimulus set was to improve experimental control during recognition testing, by allowing the researcher to control fully the degree to which participants are exposed to melodies (see Chapter 2 of the thesis, p.34). The stimuli were composed using a modal scale commonly used in world music. Sloboda and Parker (1985) describe an instance where a Western melody from a database source triggered memory for another, similar melody, known to the participant. We wished to avoid this possibility in our stimulus set, and therefore used a non-Western scale to compose the melodies. The structure of the Phrygian mode, in particular the opening semitone and final tone, violate the structures of the Western minor and major scale (see Figure 2.5). Thus, it is unlikely that our compositions would be similar to melodies known to Australian participants. To ensure consistency when measuring musical features of the stimuli, we composed all melodies on a single scale.

Details of the composition process are provided in Chapter 3 of the thesis, beginning on page 85. Melodies were composed by the candidate, using two measures obtained by Bailes (2010) of the probability of scale degree and interval width in Western melodies. We used measures derived from Western major and minor scales, rather than modal scales, as these represent the frame of reference of our Australian participant sample. The level of expectancy of a musical event represents the degree to which it accords with the listener's schemata, acquired through exposure to music. Thus, participants from a Western background are more likely to perceive musical expectancy in terms of Western scales (Krumhansl, 1991; Schmuckler, 1997; Vuvan et al., 2014).

Bailes (2010) found that the level of expectancy of scale degree and interval width was associated with stimulus distinctiveness. Wider intervallic leaps, and notes

| Note name | D | E♭ | F | G | A | B♭ | C | D |
|---|---|---|---|---|---|---|---|---|
| MIDI note | 62 | 63 | 65 | 67 | 69 | 70 | 72 | 74 |
| Major scale | D | E* | F#* | G | A | B* | C#* | D |
| Minor | D | E* | F | G | A | B♭ | C#* | D |

*Figure 2.5.* The scale used in the MUSOS Toolkit is provided in the top row in musical note names, and on the second row as MIDI note numbers. The scale is then compared to the major and minor scales of Western music on the third and fourth rows. Asterisks indicate notes which differ to the major and minor scales.

All stimuli are composed in 4/4 meter and are isochronic in rhythm, with four quarter notes per bar. Although rhythm is also important in the study of musical memory, in developing these stimuli we chose to focus on those aspects of melody (pitch, interval, tonality, and contour) which may cause a melody to be easy or difficult to remember (Deutsch, 1975, 1980; Dowling, 1978; Krumhansl, 1991; Schmuckler, 1997). Isochronic melodies are commonly used in such studies where the focus is on aspects of melody that affect memory for music (e.g., Halpern &

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distant from the tonic of the scale have a lower frequency of occurrence, and are thus perceived as distinctive. Thus, when composing melodies intended to be high in distinctive material, these less-probable events were incorporated. Conversely, when composing melodies intended to be low in distinctiveness, highly expectable events such as stepwise motion and notes close to the tonic were featured.

Positive valence for a Western listener is associated with notes close to the tonic, which are perceived as consonant. Likewise, negative valence and perceived dissonance are associated with notes distant from the tonic (Johnson-Laird, Kang, & Leong, 2012; McLachlan, Marco, Light, & Wilson, 2013; Vuvan et al., 2014). Therefore, when composing melodies intended to be high in valence, we used notes close to the tonic according to the Krumhansl and Kessler (1982) key profiles of the Western major and minor scales, and for melodies low in valence, we used notes distant from the tonic.

Bower, 1982). Advanced Max/MSP programmers may adjust the *live.step* sequencer to present their own melodies using varied rhythm.

**Tonality.** In order to ensure that there was sufficient variety within the melody collection, the stimuli were permitted to begin or end on any of the eight notes of the scale. A possible $8^8 = 16.7$ million sequences can be generated from an eight-note melody composed on an eight-note scale and $2.81e^{+14}$ for a 16-note melody on the same scale, thus sufficient degrees of freedom were available within this structure to eliminate the possibility that the stimuli were too similar.

As western modal scales consist of an identical intervallic structure, varying only by the note on which they begin (the Ionian mode being identical to the modern major scale), permitting the melodies to begin on any note of the scale meant that the melodies varied in the degree to which they conformed to Western concepts of tonality. Further analysis was conducted in the tests below using FANTASTIC to assess the implicit tonality of the melody, and the *tonalness*, or degree to which the melody correlated to a given scale (Müllensiefen, 2009b).

**Stimulus distinctiveness.** In a study of the role of distinctiveness in online recognition of melodies, Bailes (2010) used the Humdrum toolkit (Huron, 1994) to calculate the distinctiveness of scale degree and intervallic information, finding that stepwise intervals of a major second have a higher probability of occurring in Western melodies, and are thus more typical than less frequently occurring wider intervals such as the augmented fourth. In the same study, bit values were also computed indicating the relative probability of a scale degree occurring in a melody. This information was used as a guide for composition of the MUSOS stimulus set, with melodies designed to be highly distinctive including wider intervals and less frequently occurring scale degrees, whereas melodies designed to be more typical (i.e. low distinctiveness) were composed with regularly occurring notes of the scale, and stepwise passages.

**Stimulus valence.** Although a non-Western scale was used for the experiment, the majority of participants were of Western origin, and would therefore have acquired Western constructs of consonance and dissonance through passive listening experiences (Johnson-Laird et al., 2012; Levitin & Tirovilas, 2009). Therefore, when composing melodies expected to be perceived as high or low in valence, Western musicological constructs of consonance and dissonance were used, with dissonant intervals based around augmented and diminished intervals and chords included in low valence melodies, and consonant intervals based around major or minor chords and their inversions in high valence melodies (Johnson-Laird et al., 2012).

**Pilot test 1: Distinctiveness and valence ratings**

As composition according to computer-calculated values and musicological principles may not always reflect the perception of individual listeners, the set of stimuli were rated by a group of pilot testers for values of distinctiveness and valence.

**Method.** Thirty-six participants[§§] were recruited to take part in a web-based experiment. Those who were first-year students of the School of Psychology received course credit for participation; the remainder were entered into a draw to receive vouchers as remuneration.

Melodies were presented to participants in one of four randomised orders, with eight-note melodies presented in the first block of testing, and sixteen note

[§§] The sample consisted of 36 international, English-speaking participants who were recruited to take part in an online experiment. Demographic information was not collected due to experimenter error.

melodies presented in the second block. Within each block, the group of melodies was divided into four sections. Participants were instructed to take a brief break before proceeding to the next page. Participants were asked to listen carefully to each melody and rate two accompanying statements, “This melody has distinctive features”, and “This melody is likeable”. Responses were recorded on a Likert-type scale ranging from -3 to +3, where -3 indicated “strongly disagree”, 0 indicated a neutral response, and +3 indicated “strongly agree”.

**Results and discussion.** Raw values of distinctiveness and valence for each melody were summed across all participants. For eight note melodies, mean distinctiveness ratings ranged from -0.14 to 1.25 ($M$ = 0.48, $SD$ = 0.30). Total scores for each melody were then converted to z-scores, which ranged from -2.06 to 2.56. Mean valence ratings for eight note melodies ranged from -0.58 to 1.25 ($M$ = 0.17, $SD$ = 0.34), which when converted to z-scores revealed a range of -2.18 to 3.12. For sixteen note melodies, mean distinctiveness ratings ranged from -0.17 to 1.31 ($M$ = 0.47, $SD$ = 0.29), with z-scores ranging from -2.22 to 2.93. Mean valence ratings ranged from -0.50 to 1.19 ($M$ = 0.23, $SD$ = 0.31) with z-scores ranging from -2.36 to 3.12.

The full set of scores for each melody is provided with the MUSOS stimulus set (see Supplemental Material).

**Computational analysis of the stimulus set.** We computed feature summary statistics and m-type summary statistics of the melodies using FANTASTIC (Müllensiefen, 2009a). Features included pitch range, variance (standard deviation) and entropy, intervallic range, mean interval, and intervallic variance (standard deviation) and entropy. Information on tonality, including the mode of each melody (major or minor scale) and the degree to which the melody correlated with the identified scale, was also computed. Finally, the calculations included several methods of describing the contour of each melody, including Huron's (1996) eight contour types, as well as interpolation, polynomial, and step contour. Further descriptions of these statistics and the calculations by which they may be obtained are available in the FANTASTIC documentation (Müllensiefen, 2009b). The full set of statistics describing each melody is included in a spreadsheet accompanying the stimulus set.

We then conducted Bayesian correlations between the computed features of the melodies and participant ratings of distinctiveness and valence, in order to examine whether the computational analysis showed a relationship to participant ratings. Table 2.1 presents Bayes factors and Pearson correlation values with participant ratings of distinctiveness and valence. According to Jeffreys' (1961) criteria, Bayes factors of 3 or above represent substantial evidence, and Bayes factors of 10 or above represent strong evidence for the hypothesis that the variables were correlated.

Significant positive correlations were found between participant ratings of distinctiveness and variables describing pitch, intervallic, and tonal content, with weak to moderate effects. Thus, as range and variability in pitch and intervallic content increased, melodies were more likely to be perceived as distinctive rather than typical. This relationship is consistent with Bailes' (2010) calculations of distinctive pitch and intervallic content, which were used in composition of the melodies.

A weak-to-moderate correlation between distinctiveness and *tonalness*, or the degree to which a melody correlates with the Western major or minor scales, was observed. However, Temperley's (2007) statistic of *tonal clarity* showed a weak negative correlation with distinctiveness. This statistic describes the ratio between the first and second highest correlations with a Western major or minor key. Higher values indicate closer correlations with a single, rather than several keys (Temperley, 2007), therefore a negative correlation with tonal clarity indicates that melodies that were more ambiguous in tonality were perceived as more distinctive. As the tonal clarity statistic is based on the probability of a key given the pitch class set of the melody (Temperley, 2007), this finding again shows consistency with Bailes' (2010) calculations of distinctive and typical notes of the major and minor scale, used in composition of the melodies. This result is further consistent with Vuvan and colleagues' (2014) findings of a distinctiveness effect in memory for highly unexpected musical tones.

Regarding the contour of melodies, only global and local variation in step contour were related to distinctiveness. Step contour describes a curve drawn by plotting duration against pitch, thus, the moderate positive correlations found here indicate that melodies containing greater variety in contour were rated as more distinctive.

Although participant ratings of distinctiveness and valence showed a moderate positive correlation, fewer of the computed statistics describing the melodies were related to valence. Intervallic range (the difference between the maximum and minimum interval) and standard deviation were negatively related to valence, thus, melodies with less variation in intervallic content were perceived as higher in valence. However, a wider modal (most frequent) interval also predicted higher valence. Tonalness was also positively correlated with valence. This result would be consistent with Huron (2006), and Johnson-Laird and colleagues (2012) study of the perception of pleasantness in consonant and dissonant chords. As for distinctiveness, a relationship may again be observed between correlations with valence and the rules on which composition was based, where dissonant augmented and diminished intervals were used to compose melodies low in valence, whereas consonant intervals of fourths, fifths, and major and minor thirds and sixths were used frequently to compose melodies planned to be high in valence.

Table 2.1

*Bayesian Correlations Between Features of Melodies and Participant Ratings of Distinctiveness and Valence*

| | | Distinctiveness (mean rating) | Valence (mean rating) |
|---|---|---|---|
| Valence | *r* | 0.57 | - |
| | $BF_{10}$ | 4.301e +15** | |
| Pitch range | *r* | 0.41 | 0.01 |
| | $BF_{10}$ | 162,012.10** | 0.10 |
| Pitch entropy | *r* | .25 | 0.14 |
| | $BF_{10}$ | 13.16** | 0.45 |
| Pitch standard deviation | *r* | .43 | -0.02 |
| | $BF_{10}$ | 538,776.46** | 0.10 |
| Interval absolute range | *r* | 0.25 | -0.22 |
| | $BF_{10}$ | 11.33** | 4.63* |
| Interval absolute mean | *r* | 0.42 | -0.03 |
| | $BF_{10}$ | 330,634.50** | 0.11 |
| Interval absolute standard deviation | *r* | 0.25 | -0.25 |
| | $BF_{10}$ | 11.03** | 12.83** |
| Interval mode | *r* | 0.40 | 0.24 |
| | $BF_{10}$ | 48,000.32** | 7.42* |
| Intervallic entropy | *r* | 0.37 | 0.12 |
| | $BF_{10}$ | 9,500.71** | 0.32 |
| Tonalness | *r* | 0.25 | 0.23 |
| | $BF_{10}$ | 14.36** | 5.96* |
| Tonal clarity | *r* | -0.22 | -0.06 |
| | $BF_{10}$ | 4.68* | 0.13 |
| Tonal spike | *r* | 0.02 | -0.04 |
| | $BF_{10}$ | 0.10 | 0.12 |
| Interpolation contour mean gradient | *r* | 0.07 | -0.17 |
| | $BF_{10}$ | 0.15 | 1.03 |
| Interpolation contour standard deviation | *r* | 0.09 | -0.16 |
| | $BF_{10}$ | 0.18 | 0.77 |
| Interpolation contour direction change | *r* | -0.06 | -0.07 |
| | $BF_{10}$ | 0.13 | 0.14 |
| Step contour global variation | *r* | 0.43 | -0.02 |
| | $BF_{10}$ | 552,740.64** | 0.10 |
| Step contour global direction | *r* | -0.02 | 0.04 |
| | $BF_{10}$ | 0.10 | 0.11 |
| Step contour local variation | *r* | 0.42 | -0.02 |
| | $BF_{10}$ | 301,586.70** | 0.10 |
| Polynomial coefficient 1 | *r* | -0.13 | -0.13 |
| | $BF_{10}$ | 0.34 | 0.34 |
| Polynomial coefficient 2 | *r* | -0.08 | -0.08 |
| | $BF_{10}$ | 0.15 | 0.15 |
| Polynomial coefficient 3 | *r* | 0.15 | 0.15 |
| | $BF_{10}$ | 0.61 | 0.61 |

*Note:* * indicates substantial support for the hypothesis, ** indicates strong support for the hypothesis.

**Pilot test 2: Difficult versus easy to recognise stimuli**

A brief recognition test was conducted in order to establish a subset of melodies from the stimulus set for use as test items designed to be either very easy or very difficult to remember. According to Rajaram's (1996) distinctiveness-fluency framework, distinctive items are more readily identified in a test of explicit recognition, a finding that has been replicated across visual, verbal, and musical domains (Bailes, 2010; Brandt, Gardiner, & Macrae, 2006; Bülthoff & Newell, 2015; Cohen & Carr, 1975). Thus, as a starting point for identifying a set of easy and difficult to recognise items, we chose a group of melodies from the stimulus set with very high values of distinctiveness (which should be relatively easy to recognize) and a set with very low values of distinctiveness (which should be difficult to recognize). We further used the values obtained through analysis using FANTASTIC to identify musical properties on which the easy- and difficult-to-recognize melodies differed significantly.

**Method.** Participants were 26 first-year Psychology students (3 males, 23 females) at the University of Tasmania who received course credit for participation. Participants were not required to have received training in music.

The MUSOS application was configured to present participants with two recognition tests, one using the eight-note melodies, and the other using sixteen-note melodies. Two pairs of Exposure and Recognition modules were used for this design. Test administration was counterbalanced by creating two versions of the application, the first presenting participants with the eight-note test first, and the second with the sixteen-note test first.

Forty-eight melodies from each of the eight- and sixteen-note melody collections were selected as stimuli for inclusion in the pilot test. In each note-length category, the 24 melodies with the highest and lowest ratings of distinctiveness comprised the Low difficulty and High difficulty stimuli respectively.

**Procedure.** Participants were randomly assigned to complete either the eight-note recognition test or the sixteen-note recognition test first. Participants were given brief instructions on how to use the software by the experimenter[***], and then proceeded to operate the program in a self-directed manner. In the Exposure phase of each experiment, participants were presented with the 24 melodies in random order, and were asked to listen carefully to each of the melodies[†††]. Then, for the recognition test, participants were presented with the 24 previously heard and 24 novel melodies in random order. Participants were asked to rate whether they thought that the melody was one they had previously heard in the exposure phase, or a novel melody, according to the statement “I heard this melody in the previous task”, where +3 indicated “strongly agree”, and -3 indicated “strongly disagree”.

**Results and discussion.** Using the spreadsheets provided with the MUSOS Toolkit, randomisation was removed and participant ratings were calculated for Low and High difficulty melodies when presented as targets during the exposure phase, and when appearing as lures (i.e., when the melody did not appear in the exposure phase). From these values, total ratings for targets and lures for Low and High difficulty melodies of each note length were calculated.

Following initial analysis, it was discovered that some of the melodies selected were not performing as would be expected according to the values obtained in the first pilot test. We examined participants’ mean recognition ratings for each melody. In both the eight- and sixteen-note melody collections, we removed four

[***] These instructions included information on how to operate the module used for the recognition test. Therefore, participants knew in advance that their memory for melodies heard in the Exposure phase would be tested.
[†††] No inter-stimulus interval or noise mask was used between melodies.

melodies from both the Low and High difficulty categories which were most likely to be rated as being earlier presented when in fact they had not. We then ran the following analyses on the final set of 80 melodies (20 Low and 20 High difficulty melodies in each note-length category) with the aim of establishing a reliable stimulus set of high and low difficulty melodies that may be used by researchers for testing with the MUSOS Toolkit.

Mean ratings for eight and sixteen-note melodies when appearing as targets and lures are given in Table 2.2. Data for the final collection of melodies were analysed with a 2 (Condition: Target, Lure) × 2 (Difficulty: Low, High) × 2 (Length: 8 note, 16 note) repeated measures ANOVA. A large and statistically significant main effect of Condition, $F(1,25) = 25.34$, $p < .001$, $\eta_p^2 = 0.50$, indicated that participants could distinguish target melodies from lures, evidenced by higher ratings for targets than lures. This indicated that participants could distinguish target melodies from lures overall (i.e., collapsing across different level of difficulty and length).

For establishing the effect of difficulty, the critical result was a large and significant two-way interaction between Difficulty and Condition, $F(1,25) = 16.05$, $p < .001$, $\eta_p^2 = 0.39$, indicating that participants' ability to distinguish target melodies from lures varied depending on difficulty. Simple effects analyses (using a Bonferroni-corrected alpha level of .006) showed that participants were much better at distinguishing targets from lures with the low difficulty melodies than the high difficulty melodies. For low difficulty melodies, higher ratings were given to targets than lures for 8-note melodies, $t(25) = 3.82$, $p = .001$, 95%CI [3.19, 10.67], $d = 0.99$, and 16-note melodies, $t(25) = 6.86$, $p < .001$, 95%CI [7.48, 13.90], $d = 1.63$. In contrast, for high difficulty melodies there was little difference in the ratings given to targets and lures for 8-note, $t(25) = 1.50$, $p = .146$, 95%CI [ -0.88, 5.65], $d = 0.38$, and 16-note melodies, $t(25) = 0.12$, $p = .905$, 95%CI [-4.33, 4.870, $d = 0.03$.

Table 2.2

*Participant Ratings for Melodies Appearing as Targets and Lures*

| | Difficulty | | |
|---|---|---|---|
| Condition | Low | High | Overall |
| 8-note melodies | | | |
| Targets | 6.3 (6.1) | 1.3 (6.3) | 3.8 (4.7) |
| Lures | -0.6 (7.8) | -1.1 (6.2) | -0.8 (5.9) |
| 16-note melodies | | | |
| Targets | 10.8 (6.6) | 1.2 (8.3) | 6.0 (6.1) |
| Lures | 0.2 (6.5) | 0.9 (8.2) | 0.5 (5.4) |
| Overall | | | |
| Targets | 8.6 (5.4) | 1.2 (5.6) | 4.9 (4.3) |
| Lures | -0.2 (5.2) | -0.1 (6.2) | 0.2 (4.9) |

*Note:* Figures shown in parentheses indicate standard deviations.

Further exploratory analysis revealed that the advantage for low difficulty melodies emerged because low difficulty target melodies were easier to recognize, rather than because low-difficulty lures were easier to reject. For targets, higher ratings were given to low difficulty melodies than high difficulty ones for 8-note, $t(25) = 3.21$, $p = .004$, 95%CI [1.82, 8.33], $d = 0.82$, and 16-note length, $t(25) = 5.63$, $p < .001$, 95%CI [6.14, 13.24], $d = 1.29$. For lures, there was little difference in ratings between Low and High difficulty for 8- or 16-note melodies (all $t$ values < 1).

Together, the results indicate that recognition performance was better for the low difficulty melodies than the high difficulty melodies, and that this applied for 8-note and 16-note melodies.

**Computational analysis of low and high difficulty melodies**. We conducted independent-samples Bayes factor t-tests, using the default prior (0.707) to identify those variables on which the high and low difficulty melodies differed significantly. We included in this analysis both the participant ratings of distinctiveness and valence, and all variables measured using FANTASTIC. As recognition testing demonstrated that performance was better for low difficulty melodies in both the 8- and 16-note melodies, we collapsed the data to include 8- and 16-note melodies together in the low and high difficulty data sets.

Table 2.3 presents descriptive statistics and Bayes factors for the melodies. According to Jeffreys' (1961) criteria, Bayes factors above 3 represent substantial support for the hypothesis, and Bayes factors of 10 or above represent strong evidence. As evident there were significant differences on these particular variables (i.e. moderate or higher support was obtained for the hypothesis that the two groups of melodies differed).

Low difficulty melodies were higher in perceived distinctiveness and valence, as well as pitch range, pitch standard deviation and pitch entropy. Low difficulty melodies also had a higher interval absolute mean, a wider interval mode, and were higher in interval entropy. Overall, these melodies could therefore be said to contain greater variation in intervallic content. An advantage for melodies with more distinctive pitch and intervallic content is consistent with Bailes' (2010) findings regarding the role of distinctive material in the point of recognition of a melody. Tonalness in low difficulty melodies was higher, which would show consistency with Deutsch (1970, 1972, 1973) and Krumhansl's (1979, 1991) studies demonstrating the role of scale and tonal relationships in facilitating memory for melodies.

Table 2.3

*Bayes Factor t-tests and Descriptive Statistics for Low and High Difficulty Melodies.*

| Variable | $BF_{10}$ | Error % | Difficulty | Mean (SD) |
|---|---|---|---|---|
| Distinctiveness (mean rating) | 8.25e +29** | 4.12e -37 | High | 0.14 (0.12) |
| | | | Low | 0.81 (0.17) |
| Valence (mean rating) | 3.97e +6* | 3.29e -12 | High | 0.01 (0.20) |
| | | | Low | 0.46 (0.37) |
| Pitch range | 366.48** | 8.99e -8 | High | 6.76 (2.99) |
| | | | Low | 9.40 (2.53) |
| Pitch entropy | 4.68* | 1.05e -5 | High | 0.42 (0.09) |
| | | | Low | 0.47 (0.07) |
| Pitch standard deviation | 313.95** | 1.12e -7 | High | 2.46 (1.11) |
| | | | Low | 3.45 (0.99) |
| Interval absolute range | 1.27 | 1.15e -5 | High | 4.94 (3.21) |
| | | | Low | 6.31 (2.98) |
| Interval absolute mean | 62.83** | 9.78e -7 | High | 2.53 (1.26) |
| | | | Low | 3.70 (1.55) |
| Interval absolute standard deviation | 0.95 | 3.37e -5 | High | 1.88 (1.30) |
| | | | Low | 2.39 (1.21) |
| Interval mode | 1,111.91** | 2.21e -8 | High | 3.06 (1.33) |
| | | | Low | 4.61 (1.67) |
| Intervallic entropy | 440.21** | 6.96e -8 | High | 0.46 (0.07) |
| | | | Low | 0.53 (0.07) |
| Tonalness | 7.99* | 7.93e -6 | High | 0.63 (0.10) |
| | | | Low | 0.69 (0.11) |
| Tonal clarity | 5.16* | 1.01e -5 | High | 1.20 (0.13) |
| | | | Low | 1.13 (0.10) |
| Tonal spike | 0.23 | 2.15e -4 | High | 0.19 (0.03) |
| | | | Low | 0.19 (0.02) |
| Interpolation contour mean gradient | 0.28 | 2.20e -4 | High | 2.64 (2.35) |
| | | | Low | 2.97 (2.17) |
| Interpolation contour standard deviation | 0.29 | 2.19e -4 | High | 2.90 (3.00) |
| | | | Low | 3.39 (3.16) |
| Interpolation contour direction change | 0.25 | 2.19e -4 | High | 0.42 (0.37) |
| | | | Low | 0.38 (0.36) |
| Step contour global variation | 315.70** | 1.11e -7 | High | 2.32 (1.05) |
| | | | Low | 3.25 (0.93) |
| Step contour global direction | 0.24 | 2.16e -4 | High | -0.05 (0.40) |
| | | | Low | -0.07 (0.40) |
| Step contour local variation | 54.40** | 1.18e -6 | High | 0.29 (0.14) |
| | | | Low | 0.41 (0.17) |
| Polynomial coefficient 1 | 0.72 | 7.10e -5 | High | 0.28 (1.75) |
| | | | Low | -0.62 (3.03) |
| Polynomial coefficient 2 | 1.38 | 7.70e -6 | High | 0.33 (1.96) |
| | | | Low | -0.76 (2.76) |
| Polynomial coefficient 3 | 1.69 | 3.65e -6 | High | -0.22 (0.68) |
| | | | Low | 0.22 (1.12) |

*Note:* * indicates substantial support for the hypothesis, ** indicates strong support for the hypothesis.

However, low difficulty melodies were also lower in tonal clarity, i.e. more ambiguous in key, and may thus have facilitated recognition as less expectable events (Schmuckler, 1997; Vuvan et al., 2014). Interpolation contour did not differ between the two groups, however, step contour global and local variation was higher in the low difficulty melodies, thus, greater variation in contour was associated with improved recognition. This finding would be consistent with Dowling's (Bartlett & Dowling, 1980; 1978; Dowling & Bartlett, 1981) and Halpern's (1984) studies demonstrating that similar contour is highly confusable, whereas variation in contour improves discrimination.

In summary, melodies which were easier to recognise can be described as containing greater variety in pitch and intervallic content, wider intervals and greater pitch range, and greater variation in contour. In contrast, difficult-to-recognise melodies had less variation in pitch and intervallic content, and were more uniform in contour. Low difficulty melodies also correlated more closely with Western musical scales, and were more likely to correlate with a single tonality rather than multiple tonalities. These variables associated with improved recognition of melodies were also shown in the analysis of the full stimulus set above to be associated with an increase in perceived distinctiveness and valence of items, further verifying the procedure involved in composing a set of high and low difficulty melodies.

The results of recognition testing, together with computational measurement of the melodies, verified the classification of a group of stimuli from the accompanying stimulus set into a pre-packaged set of hard- and easy- to recognise items which researchers may then use for testing any of the paradigms supplied with the MUSOS Toolkit.

## Conclusion

In this paper, a computer-based application was presented, designed to facilitate ease of administration and replication of studies of explicit and implicit memory for music. The application was designed with the aim of addressing two practical methodological issues that may be hindering replication studies in music psychology, an emerging field where important findings have been made but replication rates are low (Frieler et al., 2013), specifically, difficulties in measuring recall responses and the availability of novel stimuli. The results of pilot testing with a sample of undergraduate students demonstrated that the software can be used easily by participants, and established some important characteristics of melodies in the accompanying stimulus set.

One advantage presented by a computer-based method is that it may be used for testing in the general population, whereas traditional methods involving instrumental performance or singing require trained musicians as test administrators as well as participants. The MUSOS application is easy for non-musicians to use, as demonstrated during testing where all participants were able to use the program in a self-directed manner with minimal instruction. The modular basis of the software means that a researcher with or without musical training may develop and administer tests investigating memory for musical items.

This method, although practical and easy for researchers without expert musical training to use, is by no means a panacea for understanding the full complexity of musical recall responses. The limited number of studies conducted to date into the free recall of music clearly indicates that further research is needed before we have a complete understanding of musical memory (Müllensiefen & Wiggins, 2011). The MUSOS Toolkit is intended to provide researchers with the means to build an evidence base supporting our understanding of music cognition, so that we may investigate with greater reliability the free recall of melodies, and, using the accompanying stimulus set of hard and easy to recognise melodies, replicate stem completion studies such as that of Warker and Halpern (2005), or studies of implicit memory for music such as those by Halpern and Mullensiefen (2008). The source code of the MUSOS application, its accompanying documentation and stimulus set are made freely available to researchers who may wish not only to contribute such evidence through the replication of existing studies, but also to create conceptual replications, where properties of the original study are varied or extended. While exact replications are important initially to verify that a theory may be supported, conceptual replications test the extent to which a theory may be generalised across differing conditions (Frieler et al., 2013).

One further limitation that must be acknowledged is that a single toolkit cannot be capable of replicating every historic study of music and memory. Developing a full understanding of the factors involved in memory for music is a complex undertaking. Certainly, some factors cannot be understood without the need for novel and unique paradigms, which could not easily be included within a modular framework. However, as mentioned earlier, many of these important paradigms are already well replicated in the literature. Deutsch developed her pitch comparison paradigm for a series of studies investigating the pitch memory store (Deutsch, 1970, 1972, 1973, 1974, reviewed in Deutsch, 1975), which were extended by Krumhansl (1979) to build a model describing the role of harmonic relationships in pitch memory. More recently, Mavromatis and Farbood (2012) used the same procedure to investigate the harmonic context of the comparison tone. It is noteworthy that all of these studies have involved electronic administration rather than human performance. Dowling’s studies of the differential storage of scale and contour (Bartlett & Dowling, 1980; Dowling, 1978; Dowling & Bartlett, 1981) were replicated using electronic software in a series of studies by DeWitt and Crowder (1986). Extensive study has been undertaken of cohort theory in the storage and retrieval of melodies using dynamic melody recognition paradigms (Bailes, 2010; Dalla Bella et al., 2003; Schulkind, 2004), whereas there remains a pressing need to facilitate reliable studies of free recall (Müllensiefen & Wiggins, 2011).

As MUSOS is easy to use and configure, the requirement for expert musical training on the part of the researcher is avoided. By providing participants with an accessible computer-based interface, this application resolves issues with “dirty” raw data captured through sung responses (Müllensiefen & Wiggins, 2011), and contributes further to the standardization of testing in this field, which Müllensiefen and Wiggins (2011) propose may be addressed through the use of computer technology. The importance of extending research participation to the general population, rather than those who are reliably able to sing in tune, cannot be understated; if untrained musicians continue to be excluded from studies, the results cannot be said to generalize to an understanding of music perception, as it has already been demonstrated that trained musicians listen to music differently to those without training (Mikutta, Maissen, Altorfer, Strik, & Koenig, 2014).

# Chapter 3: Study 2

## The distinctiveness effect in the recognition of musical melodies[‡‡‡]

[‡‡‡] Rainsford, M., Palmer, M. A., & Sauer, J. D. (under review). The distinctiveness effect in the recognition of musical melodies. *Submitted February, 2017, to Music Perception*

**Abstract**

Distinctive stimuli are better recognized than typical stimuli in many domains. However, the effect of distinctiveness on memory for music has received little attention. Because melodies differ from other types of stimuli (e.g., words and pictures) on certain characteristics, it cannot be assumed that the effects of distinctiveness will translate from other domains to music. This study examined the effect of distinctiveness on recognition of melodies. A set of 96 novel melodies (48 eight-note and 48 sixteen-note) were composed on a modal scale, such that half the melodies were high in distinctiveness and half low in distinctiveness. Distinctiveness was established based on computational analysis of melodic features, and subjective ratings made by participants in pilot testing. A separate group of participants studied the melodies and completed a recognition test for them. Analysis of ratings and ROC curves showed that participants' ability to distinguish between studied and unstudied melodies was greater for high-distinctiveness melodies than low-distinctiveness melodies. This advantage was due to more hits (correct recognition of studied melodies) for high-distinctiveness melodies, rather than fewer false alarms to high-distinctiveness melodies. These results indicate that the distinctiveness effect observed in other domains extends to memory for melodies.

**Keywords:** distinctiveness effect, music, melody, memory, recognition

The distinctiveness of an item refers to the degree to which an item or object possesses unusual or unique features (Schacter & Wiseman, 2006). Across domains, distinctive items have been found to be better recognized than those which are more prototypical (Brandt et al., 2006; Israel & Schacter, 1997; Schacter & Wiseman, 2006; Valentine, 1991). The distinctiveness effect in memory, first proposed by von Restorff (1933), has been replicated in visual (Bülthoff & Newell, 2015; Cohen & Carr, 1975) and verbal recognition (Dewhurst & Parry, 2010; Kausler & Pavur, 1974; Rajaram, 1998). However, few studies have investigated the role of distinctiveness in the recognition of musical material. Distinctiveness has been identified as a factor in specific aspects of music recognition, including improved encoding of melodic material in comparison to rhythmic patterns (Hébert & Peretz, 1997), facilitation of the point of recognition at which a listener can identify a melody (Bailes, 2010), and recognition of unique tones within a melody (Vuvan et al., 2014). However, no studies have examined the distinctiveness effect when recognizing whole melodies. Therefore, we tested whether a set of melodies constructed to be high in distinctive features would be better recognized by participants in an old-new recognition test than a group of melodies constructed and measured to be of low distinctiveness.

Bailes (2010) demonstrated that listeners reach the point of recognition (POR) at which they can identify a melody as one that they have previously encountered within fewer notes where the melody contains a greater amount of distinctive material. Western music theory defines a set of semantic relationships around a central pitch or *tonic* note (Vuvan et al., 2014). Within this structure, events close to the tonic are predictable and perceived as stable, whereas events that are more peripheral are perceived as relatively less stable, and thus, unexpected or distinctive (Schmuckler, 1997). Bailes (2010) calculated the probability of occurrence of intervallic and scale-degree information within a large corpus of German folk melodies, finding that notes peripheral to the scale, such as the tritone, augmented sixth and seventh, were less probable within a melody than notes close to the tonic such as the second, third, and fifth degrees of the scale. In addition, wide intervallic leaps such as the augmented fourth were found to be less probable, and thus more distinctive, than stepwise motion. In a gating paradigm experiment, where melodies were presented note-by-note, melodies with a high content of such distinctive information were associated with an earlier POR at which the melody could be identified by the participant as previously presented, with 84.9% of the variance in POR explained by the level of distinctive information contained in its melodic, rhythmic, and scalar features (Bailes, 2010).

We examined whether distinctiveness enhances recognition of whole melodies. Although distinctive material leads to recognition of a melody after fewer notes (Bailes, 2010), when the task involves attempting to recognize an entire melody, it cannot be taken for granted that the advantage for distinctive versus typical stimuli found in other domains will translate to music. Schmuckler (1997) and later Vuvan and colleagues (2014) found evidence that recognition in music is not only enhanced for unpredictable—and, thus, distinctive—stimuli, but also for highly predictable events. Schmuckler (1997) randomized the final two measures of eight measure melodies, finding that those sequences which resulted in predictable patterns which accord with a Western tonal schema were better recognized. However, a trend was also observed where those melodies with highly unexpected material were also better remembered than those with a moderate level of expectancy. Likewise, Vuvan and colleagues (2014) found, when testing recognition of single target tones within a melody, that tones of both high and low expectancy with relation to their distance from the tonic note of the scale were better recognized than those of moderate expectancy. No difference was observed between high and low expectancy tones. According to these findings, a simple advantage of distinctive over typical stimuli, as found in other domains, would not be likely to be found in music. Should no difference be found in a recognition test between responses to distinctive and typical melodies, this would then support the operation of such a U-shaped model in music.

However, the typical pattern of results showing improved recognition of distinctive items over those which are more typical would not necessarily be precluded by these findings. Although distinctiveness and expectation are similar constructs, both based on an accumulation of past experiences of musical events (Huron, 2006), they are not necessarily the same. Low expectancy notes in relation to the tonic might well be perceived as distinctive within the context of a highly tonal passage (such as the examples provided in Vuvan and colleagues' (2014) study), but a highly predictable musical pattern may also be considered distinctive depending on the context in which it is presented. Classical period compositions (e.g., Beethoven's 5th Symphony) provide a good example of highly expectable and indeed memorable music which is centered around the tonic of the scale, yet presented in a distinctive manner. These differences highlight the importance of testing with a stimulus set of items rated specifically for their perceived distinctiveness.

Müllensiefen and Halpern (2014) found evidence that would support a traditional advantage for distinctive over typical stimuli when recognizing whole melodies. Following an old-new recognition test of popular melodies, computer-based analysis was used to identify those features which elicited greater accuracy in performance. Correct recognition of old melodies was associated with infrequently used motifs in relation to the test set, and with a varied contour of wide intervallic leaps, features similar to those found by Bailes (2010) to be less probable, and thus distinctive. In contrast, melodies associated with increased misses (failure to recognize an item as old) were found to have flat, stepwise contours, with motifs commonly used across the test set of stimuli.

Such features might then be used in the composition of a novel set of stimuli for the purposes of testing for a distinctiveness effect in music. In the present experiment, we used Bailes' (2010) findings regarding scale degree and interval probability as the basis for creating melodies of high distinctiveness (featuring many low probability events) and melodies of low distinctiveness (featuring many high probability events). These melodies were then submitted to computational analysis using the software FANTASTIC (Müllensiefen, 2009a), to confirm that the high and low distinctiveness melodies differed in musical features (pitch, contour, interval, and tonality). Subjective ratings of distinctiveness for the melody set were also obtained from a group of pilot testers[§§§].

We then conducted a recognition test with a separate group of participants to investigate the effect of distinctiveness in eight- and sixteen-note melodic stimuli. Testing was conducted in two blocks, one for each stimulus length. In each block of trials, participants first listened to a counterbalanced selection of 24 high and low distinctiveness melodies, and were then tested for recognition of these melodies

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[§§§] These were the same participants as for Study 1. The aim of Study 1 was to develop a final stimulus set of melodies that were hard or easy to remember. As a starting point to establish this set of melodies, we used the ratings of distinctiveness obtained in Study 1. However, melodies which were less reliable as "hard" or "easy" to recognise were eliminated from the data set prior to analysis in Study 1.
It remained unclear in the literature whether distinctiveness affects memory for whole melodies. Therefore, we reanalysed the full data set to answer this question in Study 2.

within the full group of 48 melodies. If distinctiveness improves recognition in music, following Bailes (2010) and Müllensiefen and Halpern (2014), we would expect that in both tasks performance would be greater for melodies rated as being highly distinctive than those rated as highly typical. However, if we found no difference between responses to distinctive and typical melodies, this would support the U-shaped model of expectancy and distinctiveness proposed by Vuvan and colleagues (2014).

## Method

### Participants

Participants were 26 first-year Psychology students (3 males, 23 females) attending the University of Tasmania, who participated as part of a coursework requirement.

### Stimulus creation and selection

Stimuli consisted of 96 melodies, 48 of eight-note length and 48 of sixteen-note length, selected from a larger corpus of 156 melodies. For each stimulus length, 24 melodies of high and 24 of low distinctiveness were included. All melodies were composed to an isochronic rhythm of eight quarter-notes to hold rhythmic factors constant (Hébert & Peretz, 1997). Stimuli were composed on a modal scale commonly used in world musics (*Maqam Kurd*, in Arabic music, also known as the *Phrygian mode* in medieval music), in order that melodies would be less likely to cue a similar, familiar melody in memory (Sloboda & Parker, 1985).

Stimuli were composed according to two measures used by Bailes (2010) to determine the relative level of distinctiveness of a melody: scale degree probabilities and intervallic probability. Bailes (2010) used the Humdrum toolkit (Huron, 1994) to compute a series of bit rates indicating the relative probability of occurrence of each scale degree within Western major or minor scales. Wider intervallic material was also found to have a lower frequency of occurrence (Bailes, 2010), a finding supported by Müllensiefen and Halpern's (2014) analysis of the features of distinctive melodies. These findings were then used to create the stimulus set; when composing melodies of high distinctiveness, wider intervallic leaps and less-frequently used notes of the scale were included, whereas melodies of low distinctiveness comprised commonly used notes of the scale, with flat, stepwise contours.

Although the data presented by Bailes (2010) is for Western major and minor scales, participants with a Western listening background would be likely to perceive melodies in terms of Western constructs of consonance and dissonance acquired through passive listening experiences (Johnson-Laird et al., 2012; Levitin & Tirovilas, 2009). Therefore, the bit rate data for major and minor scales was used with the expectation that a Western listener would perceive a novel melody within the context of already acquired schemata (Vuvan et al., 2014).

**Subjective rating of stimuli.** The complete set of 156 melodies was then normed by a group of 36 participants for values of distinctiveness. Participants were asked to rate the statement "This melody has distinctive features" on a seven point Likert-type scale ranging from -3 to +3, where +3 indicated "strongly agree", 0 indicated "neither agree or disagree", and -3 indicated "strongly disagree". Raw scores for each melody were summed and converted to z-scores, and the 24 highest and lowest rated melodies from each note-length category were selected, for a total of 96 melodies forming the stimulus set for the experiment.

**Computational analysis of stimuli.** The final selection of 96 melodies were submitted to computational analysis using the software FANTASTIC (Müllensiefen, 2009a), to verify that the high and low distinctiveness stimulus sets differed in musical properties relevant to the perception of distinctiveness.

We computed feature summary statistics and m-type summary statistics of the melodies, analyzing pitch, interval, contour, and tonality. Feature summary statistics identify aspects of a melody which are known to be important in encoding, such as information about pitch, intervallic features, tonality, and contour. In contrast to the variables describing whole melodies in feature summary statistics, m-type features examine the frequency of occurrence of short sub-segments of melodies or motifs, similar to the concept of n-grams in linguistics (Müllensiefen & Halpern, 2014). A complete description of the calculation of these statistics is available in the FANTASTIC documentation (Müllensiefen, 2009b). While we composed our distinctive and typical melodies according to the features identified by Müllensiefen and Halpern (2014) as important in correctly recognizing melodies (e.g., varying versus flat, stepwise contours) we were unable to use the same corpus-based measures which they tested, as these cannot presently be calculated using FANTASTIC in a corpus of melodies with isochronic rhythm. Due to this limitation, we also removed from the testset those features which described rhythm and were thus uniform across all melodies.

Pitch features analyzed included pitch range, variance (standard deviation) and entropy. For intervallic features, we computed intervallic range, mean interval, intervallic variance (standard deviation) and entropy. Three different methods were used to calculate the contour of melodies: interpolation contour (mean, standard deviation, and changes in interpolation contour), step contour global variation and direction, and local variation, and three polynomial coefficients describing contour. Analysis of the tonality of the melodies included Temperley's (2007) statistics of *tonalness*, which describes the degree to which melodies correlate with Western major or minor scales, and *tonal clarity*, which describes the degree of ambiguity in tonality. Higher values indicate closer correlations with a single key, rather than multiple keys, and are thus less ambiguous in tonality. *Tonal spike* further describes variation in tonality through division of the most highly correlated scale by the sum of all correlation values (Müllensiefen, 2009b).

We then conducted two analyses, the first to test whether participant ratings of distinctiveness corresponded with variations in properties of the melodies, and the second to establish that the two groups of melodies differed significantly in properties that would cause them to be perceived as high or low in distinctiveness.

To determine whether participant ratings of distinctiveness corresponded to an increase in melodic features which might be described as more or less distinctive, we conducted Bayesian correlations between the computed features of melodies and subjective ratings of distinctiveness. We used Bayesian correlations to avoid the risk of inflating Type II error when applying an alpha correction for such a large number of comparisons. Table 3.1 presents Bayes factors and Pearson correlations between participant ratings of distinctiveness and the set of features calculated. According to Jeffreys' (1961) criteria, Bayes factors of 3 or above represent substantial evidence, and Bayes factors of 10 or above represent strong evidence for the hypothesis that the variables were correlated.

Table 3.1.

*Bayesian Correlations Between Features of Melodies and Participant Ratings of Distinctiveness*

| | | Distinctiveness (mean rating) |
|---|---|---|
| Pitch range | *r* | .49 |
| | $BF_{10}$ | 51,289.56** |
| Pitch entropy | *r* | .32 |
| | $BF_{10}$ | 19.46** |
| Pitch standard deviation | *r* | .51 |
| | $BF_{10}$ | 133,359.80** |
| Interval absolute range | *r* | .32 |
| | $BF_{10}$ | 17.02 |
| Interval absolute mean | *r* | .53 |
| | $BF_{10}$ | 383,102.15** |
| Interval absolute standard deviation | *r* | .31 |
| | $BF_{10}$ | 12.02** |
| Interval mode | *r* | .50 |
| | $BF_{10}$ | 60,233.81** |
| Intervallic entropy | *r* | .45 |
| | $BF_{10}$ | 4,071.45** |
| Tonalness | *r* | .36 |
| | $BF_{10}$ | 80.38** |
| Tonal clarity | *r* | -.28 |
| | $BF_{10}$ | 4.76* |
| Tonal spike | *r* | .01 |
| | $BF_{10}$ | 0.13 |
| Interpolation contour global direction | *r* | .03 |
| | $BF_{10}$ | 0.13 |
| Interpolation contour mean gradient | *r* | .10 |
| | $BF_{10}$ | 0.21 |
| Interpolation contour standard deviation | *r* | .13 |
| | $BF_{10}$ | 0.29 |
| Interpolation contour direction change | *r* | -.04 |
| | $BF_{10}$ | 0.14 |
| Step contour global variation | *r* | .51 |
| | $BF_{10}$ | 136,711.05** |
| Step contour global direction | *r* | .01 |
| | $BF_{10}$ | 0.13 |
| Step contour local variation | *r* | .53 |
| | $BF_{10}$ | 353,835.32** |
| Polynomial coefficient 1 | *r* | -.16 |
| | $BF_{10}$ | 0.42 |
| Polynomial coefficient 2 | *r* | -.08 |
| | $BF_{10}$ | 0.17 |
| Polynomial coefficient 3 | *r* | .20 |
| | $BF_{10}$ | 0.80 |

*Note:* * indicates substantial support for the hypothesis, ** indicates strong support for the hypothesis.

We found small-to-moderate positive correlations between distinctiveness and all pitch and intervallic features, representing strong support for the hypothesis. Thus, melodies which contained greater range and variability in pitch (*pitch entropy, pitch standard deviation*), wider intervals (*interval absolute range, interval absolute mean, interval mode*) and greater variability in the size of intervals used (*interval entropy*) were perceived as more distinctive by participants. Composition of the distinctive melodies by using more unusual notes of the scale and wider intervallic leaps therefore resulted in an increase in pitch and intervallic variance, which corresponded with increased perception of melodies as distinctive by listeners.

A small-to-moderate positive correlation was also found between the *tonalness* of melodies and distinctiveness, representing strong support for the hypothesis. This was surprising, as it indicated that greater correspondence to a Western major or minor scale was perceived as distinctive, rather than typical. However, a weak-to-moderate negative correlation between *tonal clarity* and distinctiveness, representing substantial support for the hypothesis, indicated that as melodies became more ambiguous in key, they were perceived as more distinctive. A decrease in tonal clarity would have occurred via the use of less predictable notes of the musical scale when composing distinctive melodies. Although *tonal spike* might also be expected to correlate with distinctiveness, examination of the values obtained for our melodic corpus revealed a range of only 0.12 between the minimum value of 0.14 and the maximum of 0.26. This lack of variability may therefore have constrained our ability to obtain a meaningful correlation.

*Step contour* of a melody is calculated from a vector drawn by plotting normalised duration values on the x-axis, and pitch values on the y-axis (Müllensiefen, 2009b). Global variation refers to the standard deviation of the step contour vector, whereas local variation is calculated from the mean absolute difference between adjacent values of the vector. We found strong, positive correlations between both values and perceived distinctiveness, representing strong support for the hypothesis. The wider intervallic leaps used in composition of the distinctive melodies would have resulted in greater variation in contour both at an overall (i.e. global) and local level; such variation was perceived as more distinctive. Step contour global direction did not correlate with distinctiveness, however, as this statistic describes whether a melody descends or rises overall, it would not be expected to be related to perceptions of distinctiveness.

However, support for correlations between distinctiveness and other measures describing contour was not obtained. While it was surprising that global and local step contour were related to distinctiveness, but interpolation and polynomial contour were not, this may have been due to the brevity of the melodies. Interpolation contour describes a melody as series of gradients interpolating between the high and low points of a melody over set points in time (Müllensiefen, 2009b; Müllensiefen & Halpern, 2014). Thus, this statistic may not sufficiently capture variation in contour in brief melodies. Likewise, representation of contour as the coefficient of a polynomial curve may be better suited to longer and more complex melodies.

In summary, computational analysis of the stimulus set verified that the methods used to compose melodies high in distinctiveness resulted in an increase in melodic, intervallic, contour and tonal complexity. Composition of stimuli using Bailes' (2010) measures of scale-degree and interval expectancy resulted in melodies which were perceived to be high or low in distinctiveness, according to participant ratings. Further, these compositional methods resulted in the production of a set of melodies which differed according to a specific set of musical features, measured using FANTASTIC (Müllensiefen, 2009a), which appear to be associated with perceived distinctiveness.

The factors identified in our study as associated with distinctiveness have some similarity to those which Müllensiefen and Halpern (2014) identified as contributing to improved recognition of old items. While their study did not directly test distinctiveness, melodies with a highly varied contour and unusual motifs were associated with improved recognition. Although their model identified a different measure of contour as predicting recognition (interpolation contour, cf. step contour in our study) this may be due to differences in stimulus type, as their study used longer melodic phrases taken from pop melodies. We were also unable to measure the m-type and duration-based features which they used due to the isochronic measure of our stimuli, and so further comparison with their results is limited. However, composition of a melody with increased variety in pitch and intervallic content, as associated with distinctiveness in our study, would arguably result in a melody with more unusual motifs. Further research is therefore needed to build a complete model of melodic and rhythmic features which predict distinctiveness.

As a final measure, to ensure that the two groups of melodies differed sufficiently in musical features that would be perceived as distinctive, we conducted Bayesian independent samples t-tests using the default prior (0.707) to compare the two groups of melodies on all the computed features. As above, we selected Bayesian t-tests due to the risk of inflating type II error when applying an alpha correction after such a large number of comparisons. Table 3.2 presents descriptive statistics and Bayes factors for the comparisons between high and low distinctiveness melody groups.

Table 3.2

*Bayes Factor t-tests and Descriptive Statistics for Low and High Difficulty Melodies.*

| Variable | $BF_{10}$ | Error % | Distinctiveness | Mean (SD) |
|---|---|---|---|---|
| Distinctiveness (mean rating) | 4.727e +34** | 1.12e -41 | High | 0.81 (0.17) |
| | | | Low | 0.14 (0.13) |
| Pitch range | 3,157.10** | 2.29e -9 | High | 9.57 (2.58) |
| | | | Low | 6.85 (2.92) |
| Pitch entropy | 12.89** | 3.31e -6 | High | 0.47 (0.07) |
| | | | Low | 0.42 (0.09) |
| Pitch standard deviation | 3,035.37** | 2.36e -9 | High | 3.52 (1.01) |
| | | | Low | 2.50 (1.08) |
| Interval absolute range | 10.46** | 4.93e -6 | High | 6.69 (3.08) |
| | | | Low | 4.82 (3.00) |
| Interval absolute mean | 6,092.45** | 1.43e -9 | High | 3.93 (1.66) |
| | | | Low | 2.47 (1.14) |
| Interval absolute standard deviation | 6.87* | 1.08e -5 | High | 2.53 (1.22) |
| | | | Low | 1.83 (1.20) |
| Interval mode | 2,869.41** | 2.46e -9 | High | 4.57 (1.72) |
| | | | Low | 3.06 (1.34) |
| Intervallic entropy | 496.95** | 7.47e -9 | High | 0.53 (0.07) |
| | | | Low | 0.47 (0.08) |
| Tonalness | 11.78** | 3.93e -6 | High | 0.69 (0.10) |
| | | | Low | 0.63 (0.10) |
| Tonal clarity | 12.77** | 3.36e -6 | High | 1.14 (0.11) |
| | | | Low | 1.22 (0.13) |
| Tonal spike | 0.22 | 3.27e -4 | High | 0.19 (0.02) |
| | | | Low | 0.19 (0.03) |
| Interpolation contour global direction | 0.23 | 3.38e -4 | High | -0.33 (0.86) |
| | | | Low | -0.40 (0.77) |
| Interpolation contour mean gradient | 0.43 | 8.86e -7 | High | 3.23 (2.38) |
| | | | Low | 2.63 (2.29) |
| Interpolation contour standard deviation | 0.60 | 7.23e -7 | High | 3.78 (3.33) |
| | | | Low | 2.80 (2.94) |
| Interpolation contour direction change | 0.22 | 3.24e -4 | High | 0.42 (0.37) |
| | | | Low | 0.42 (0.39) |
| Step contour global variation | 3,067.80** | 2.35e -9 | High | 3.32 (0.95) |
| | | | Low | 2.35 (1.02) |
| Step contour global direction | 0.23 | 3.36e -4 | High | -0.05 (0.39) |
| | | | Low | -0.08 (0.39) |
| Step contour local variation | 4,537.42** | 1.77e -9 | High | 0.44 (0.19) |
| | | | Low | 0.28 (0.13) |
| Polynomial coefficient 1 | 0.74 | 6.36e -7 | High | -0.52 (2.94) |
| | | | Low | 0.32 (1.86) |
| Polynomial coefficient 2 | 0.37 | 9.69e -7 | High | -0.25 (3.43) |
| | | | Low | 0.39 (2.16) |
| Polynomial coefficient 3 | 2.29 | 3.16e -7 | High | 0.18 (1.07) |
| | | | Low | -0.25 (0.70) |

*Note:* * indicates substantial support for the hypothesis, ** indicates strong support for the hypothesis.

These analyses revealed that the high and low distinctiveness melody sets differed in human ratings of distinctiveness, as well as differing on the same computed properties identified above as correlating with perceptions of distinctiveness. Strong support was obtained for greater pitch and intervallic variation in the high distinctiveness melodies than the low distinctiveness set, although the difference between groups was lesser for interval absolute standard deviation, but still substantial according to Jeffrey's (1961) criteria. Strong support was also obtained that high and low distinctiveness melodies differed in tonalness and tonal clarity; as for the correlational analyses, the high distinctiveness melodies were higher in tonalness, but lower in tonal clarity. The two groups of melodies did not differ in tonal spike, interpolation contour measures, step contour global direction, and polynomial contour measures. However, as noted above these properties were not observed to be related to perceived distinctiveness in this melody set. Thus, the analysis confirmed that the two melody sets differed in musical features that were also associated with perception of a melody as distinctive.

**Materials**

A custom computer program was designed in Max/MSP (Cycling '74, 2014a) for the purpose of the experiment. Stimuli were presented to participants during the exposure phase using a *live.step* sequencer object, with all pitch and timing cues removed. Notes were represented as black square blocks on a light grey background (see Figure 3.1). Participants used the Play button to listen to each melody once, and then used the Next Melody button to load the next melody. A piano sound (MIDI channel 1) was used for output so as to provide a pleasant but neutral timbre.

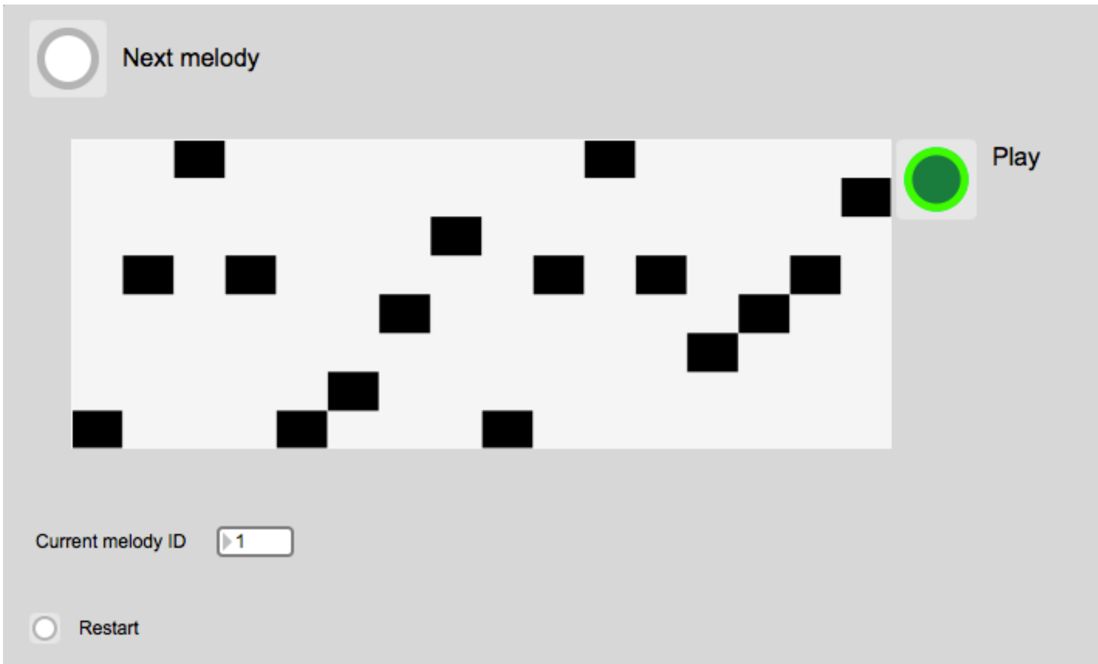


*Figure 3.1.* Participant view of stimulus presentation in the Exposure phase.

For the recognition test, the sequencer was removed and replaced with a progress bar, to ensure that participants did not use the visual display of melodies to cue recognition. Participants used the Play button to listen once to each melody, before rating whether they had heard the melody in the previous exposure phase, using either a dial or the up and down arrows to select the desired value (see Figure 3.2). After providing their rating, participants used the Next Melody button to load the next melody.

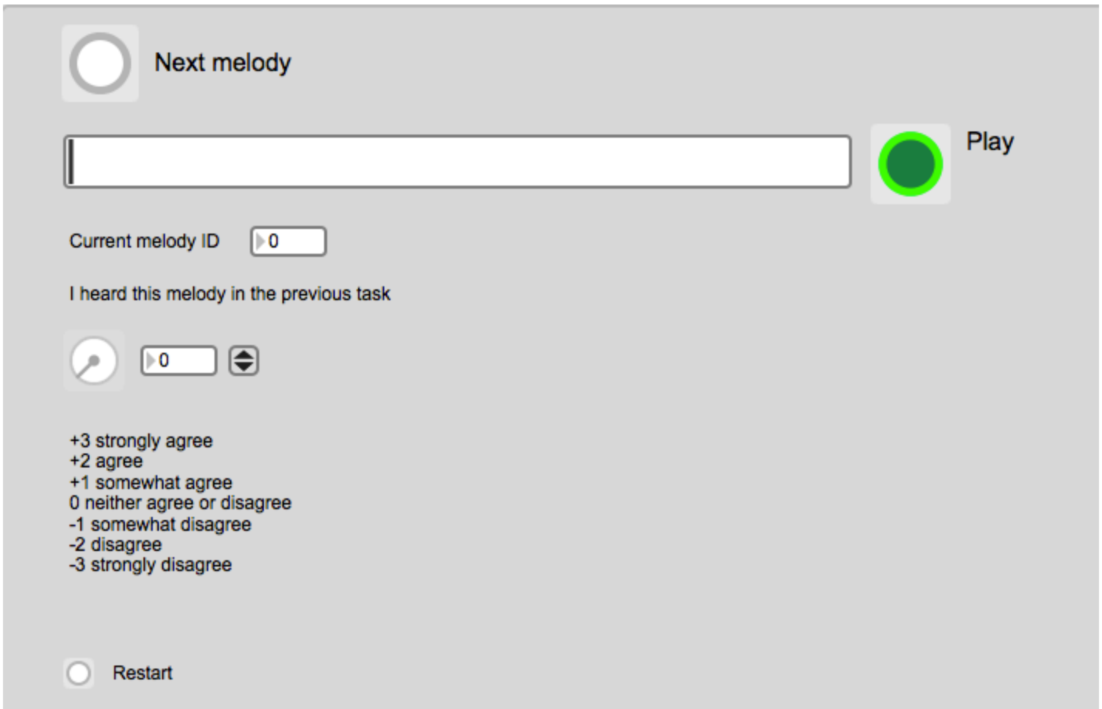


*Figure 3.2.* Participant view of interface for rating of melodies during Recognition testing. The sequencer object was removed and replaced with a progress bar.

**Procedure**

Participants completed two block of trials, one for the eight-note melodies, and one for the sixteen-note melodies. Participants were randomly assigned to complete either the eight-note or sixteen-note trials first. Each block of trials followed the same procedure, as follows.

During the exposure phase, participants were first presented with the 24 melodies in random order, and were asked to listen carefully to each of the melodies[****]. Participants then completed a recognition test comprising the 24 previously heard melodies and 24 novel melodies in randomized order. For each melody, participants rated their level of agreement with the statement "I heard this

[****] No inter-stimulus interval or noise mask was used between melodies.

melody in the previous task” on a 7-point scale ranging from -3 (*strongly disagree*) to +3 (*strongly agree*) with a midpoint of zero (*neither agree nor disagree)*.

## Results

Receiver Operating Characteristic (ROC) curve analysis was conducted on the participant ratings using pROC (Robin et al., 2011). This method of analysis involves plotting the cumulative percentage of hits (HR) against false alarms (FAR) for each level of confidence in a decision, in order to obtain a measure of diagnostic accuracy in recognition. From this plot, the Area Under the Curve (AUC) is calculated. The diagonal line on the ROC curve plot spanning 0% to 100% has an AUC of 50%, indicating performance at chance level, and an AUC of 100% indicates perfect memory performance (Swets, 1973).

Results were calculated for sixteen- and eight- note melodies separately. In the sixteen-note melodies, the Area Under the Curve (AUC) for melodies of High distinctiveness was well above chance at 87.13% (95%CI [77.93%, 96.33%]), whereas performance approximated chance for melodies of Low distinctiveness at 51.63% (95%CI [35.57%, 67.68%]). A bootstrapped test ($n$ = 2000) revealed that the difference between the two curves was significant, D = 3.62, $p < .001$. Thus, a significant advantage was found in the sixteen-note melodies for distinctive over typical melodies (see Figure 3.3).

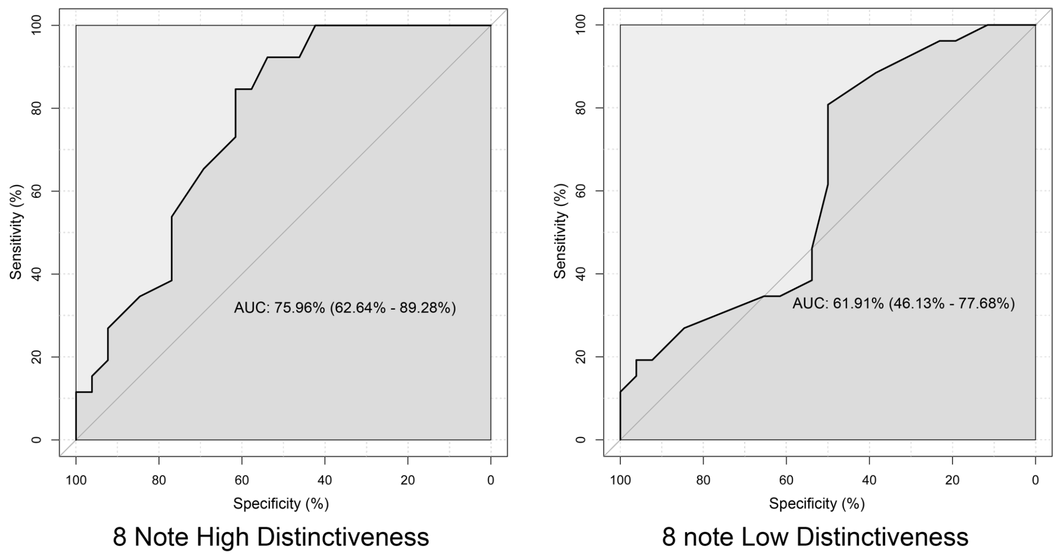


*Figure 3.3.* ROC curve analysis of eight-note melodies. Performance was improved in the High Distinctiveness melodies although the difference between the two groups did not reach significance.

In the eight-note melodies, a similar pattern of improved performance for distinctive melodies was found. The AUC for melodies of High distinctiveness was again above chance at 75.96% (95%CI [62.64%, 89.28%]). Performance for melodies of Low distinctiveness was lower, with an AUC of 61.91%, (95%CI [46.13%, 77.68%]). A bootstrapped test ($n$ = 2000) revealed that the difference between the two curves was not statistically significant, D = 1.66, $p$ = .097 (see Figure 3.4).

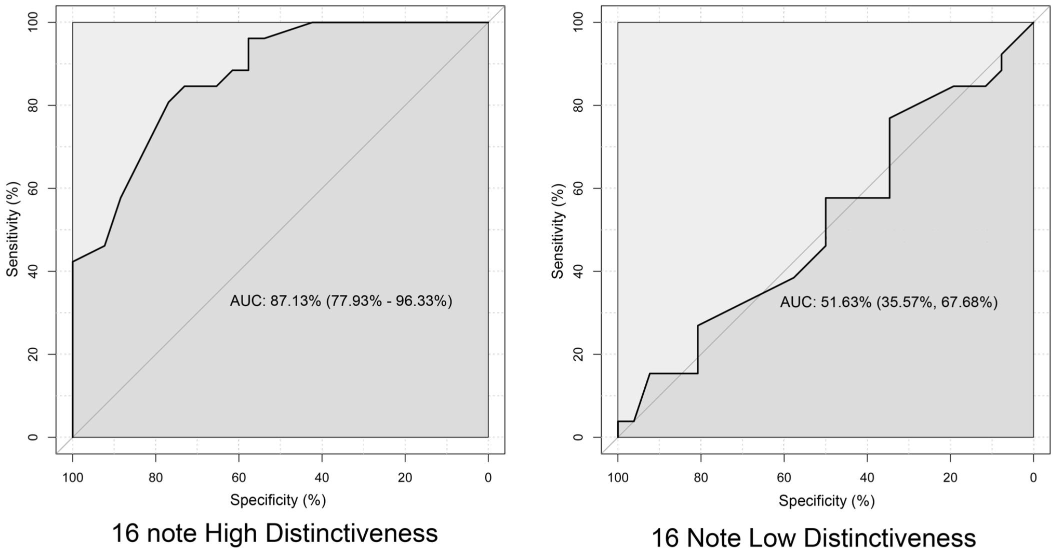


*Figure 3.4.* ROC curve analysis of sixteen-note melodies. A significant advantage was found for melodies of High Distinctiveness, whereas performance for Low Distinctiveness melodies was only just above chance.

Taken together, these ROC analyses indicate that the High distinctiveness melodies were better recognized than those of Low Distinctiveness in both stimulus length categories. Further analysis was then conducted to determine whether the source of this advantage was due to an increased number of hits or a reduction in false alarms, by examining separately the ratings for Target melodies, where the melody was heard during the exposure phase, and Lure melodies, where the melody did not appear in the exposure phase.

To examine whether distinctive melodies were better recognized as earlier-heard when appearing as targets, and better identified as novel when appearing as lures, we conducted two (Distinctiveness: High, Low) x 2 (Length: 8 note, 16 note) repeated measures ANOVAs. Table 3.3 presents descriptive statistics for 8 and 16-note melodies when appearing as targets and as lures separately.

Table 3.3.

*Mean Participant Recognition Ratings For Melodies When Appearing As Targets Or Lures*

| | 8 note melodies | | 16 note melodies | |
|---|---|---|---|---|
| | High Distinctiveness | Low Distinctiveness | High Distinctiveness | Low Distinctiveness |
| Targets | 6.65 (5.83) | 3.58 (6.84) | 10.77 (8.62) | 1.38 (9.94) |
| Lures | -0.54 (8.82) | -2.04 (7.09) | 0.81 (7.77) | 0.04 (9.13) |

*Note:* Figures shown in brackets are standard deviations.

For Target melodies, a 2 (Distinctiveness: High, Low) x 2 (Length: 8 note, 16 note) repeated measures ANOVA revealed a significant, large effect of Distinctiveness, $F(1,25) = 18.17, p< .001, \eta_p^2 = 0.42$, indicating that melodies of High Distinctiveness received a significantly greater number of hits than those of Low Distinctiveness. The main effect of Length was not significant, $F(1,25) = 0.42$, $p = .526, \eta_p^2 = .02$. However, the large, significant interaction indicated that the effect of Distinctiveness on recognition differed between the sixteen-note and eight-note melodies, $F(1,25) = 8.29, p = .008, \eta_p^2 = 0.25$.

We then conducted paired-samples *t*-tests to break down the effect of Distinctiveness for sixteen- and eight-note target melodies. The results of this analysis confirmed that in both stimulus lengths, the High Distinctiveness melodies produced a greater number of hits for Target melodies, but the effect was larger for sixteen-note than eight-note melodies.

For sixteen-note melodies, the significantly higher rating for High distinctiveness melodies in comparison to Low distinctiveness represented a large increase in hits, *MD* = 9.38, *SD* = 10.93, 95%CI [4.97, 13.80], $t(25) = 4.38$, $p < .001$, $d = 1.01$. Likewise, for the eight-note melodies, a significant, moderate increase in hits was observed in the High distinctiveness melodies in comparison to Low distinctiveness, *MD* = 3.08, *SD* = 7.36, 95%CI [0.10, 6.05], $t(25) = 2.13$, $p = .043$, $d = 0.48$.

We then conducted a 2(Distinctiveness: High, Low) x 2 (Length: 8 note, 16 note) repeated measures ANOVA on Lure melodies. This revealed that the main effects of Distinctiveness, $F(1,25) = 0.75$, $p = .375$, $\eta_p^2 = 0.03$, and Length, $F(1,25) = 2.31$, $p = .141$, $\eta_p^2 = 0.09$, were not significant, and no interaction occurred, $F(1,25) = 0.06$, $p = .806$, $\eta_p^2 = 0.002$. Thus, no difference in false alarms was found between the High and Low Distinctiveness melodies.

## Discussion

We tested whether the distinctiveness effect found in recognition memory tests across many domains could be demonstrated in music, in a recognition test of eight-note and sixteen-note melodies. A significant advantage was found for both short and long distinctive melodies over melodies rated as highly typical. The results of both ROC curve analysis and inferential testing confirmed that distinctive melodies were significantly better recognized as targets.

This result extends the findings of Bailes (2010) and Müllensiefen and Halpern (2014), who used computer-based modeling to demonstrate that improved recognition was associated with an increase in musical features which could be described as distinctive. In our study, we first used computer-based analysis as well as participant ratings to develop a set of high and low distinctiveness stimuli, and then conducted a recognition test using these stimuli to demonstrate an advantage for distinctive items in the recognition of whole melodies. Although the measures that we used differed from those used by Müllensiefen and Halpern (2014), the model which they identified has some similarities to our findings, as melodies which contained greater variety in contour, and infrequently used motifs in relation to the testset were associated with improved recognition. In our study, increased variety in contour, along with increased variation in pitch and intervallic content was associated with distinctiveness. Due to the isochronic nature of our stimuli, we were unable to measure m-type based features, which would allow comparison of motifs across the testset. However, in music composition, the use of varying interval and pitch content would be likely to result in such unusual motifs. Further research is therefore needed to build a complete model of melodic and rhythmic features which predict the perception of distinctiveness.

The results of our study contrast those of Schmuckler (1997) and Vuvan and colleagues (2014), who found an advantage for highly expectable items as well as those which were highly unexpected. While Vuvan and colleagues (2014) attributed the advantage found in their study for highly unpredictable events to distinctiveness, versus an availability heuristic facilitating recognition of highly predictable items, their stimuli were classified by participants according to expectancy, and not distinctiveness. Testing in the present study using a set of musical items measured for their distinctiveness, rather than expectancy, shows that, as Vuvan and colleagues (2014) discuss, improved memory for highly expected, schema congruous events is due to factors separate to the advantage found for distinctive material.

We also observed an interaction of distinctiveness and melody length, such that the distinctiveness effect was greater for longer melodies. There is some precedent in the broader memory literature for a link between stimulus length and distinctiveness. For example, long words that are distinctive because they are presented in a list of short words are remembered better than short words presented in a list of long words (Hulme et al., 2006). However, in that study, items were distinctive specifically because of their length, and such results do not predict that manipulations of intrinsic distinctiveness will have stronger effects for longer stimuli than shorter stimuli. One possible explanation for our results is that the temporal nature of music allows the distinctiveness effect to accumulate over time. Bailes (2010) observed that, in addition to an advantage for momentary distinctive information, earlier points of recognition (POR) were observed where melodies contained a greater amount of distinctive material prior to the POR. Thus, it could be that longer melodies provided more scope for participants to develop a sense of distinctiveness during exposure, which may have resulted in a stronger effect of distinctiveness at test.

The distinctiveness effect is normally associated with a corresponding reduction in false identifications as well as an increase in hits (Dodson & Schacter, 2001; Israel & Schacter, 1997; Schacter, Cendan, Dodson, & Clifford, 2001), as per the *mirror effect* (Glanzer & Adams, 1985). While this was not found in our study, as no difference was found in false identifications of high and low distinctive lures, an absence of the mirror effect does not preclude an advantage for correct recognition of distinctive targets (Pazzaglia, Staub, & Rotello, 2014), and the mirror effect does not always generalize from verbal to other types of stimuli (Glanzer & Adams, 1985). As this is the first study of the distinctiveness effect in the recognition of whole melodies, further testing is required to determine whether the small sample size contributed to a lack of an effect of distinctiveness on false alarms. However, Müllensiefen and Halpern (2014) also did not find evidence of a mirror effect for distinctive items, as some differences were identified in the factors which predicted correct rejection of lures, in comparison to those which contributed to recognition of old items. Although infrequently used (i.e. distinctive) motifs were identified as a factor in both models, contrary to the mirror effect, these were more likely to elicit judgements of a melody as previously heard in both targets and lures. Although we were unable to test for the same corpus-based features in our stimuli due to their isochronic rhythm, our result is consistent with that of Müllensiefen and Halpern (2014) in contributing to an emerging finding that the distinctiveness effect operates differently in musical recognition to other stimulus types.

This experiment represents a further contribution towards the understanding of the role of distinctiveness in the recognition of musical material. The findings suggest that, as for other domains, whole melodies that are rich in distinctive features are better recognized, and identified with greater accuracy, than those of low distinctiveness. However, the number of studies examining distinctiveness in music is still very low. Those which have found an advantage for distinctive items have used different computer-based techniques to identify distinctive characteristics of musical material. Although the factors which these studies have identified are similar, further research is needed to develop a more complete model of melodic features which are perceived as distinctive. Further studies replicating the distinctiveness effect, and investigating factors which lead to false alarms as well as correct recognition, are also needed in order for the distinctiveness effect in music to be fully understood.

## Chapter 4: Study 3

# Blurred lines: Why music composition is highly susceptible to unconscious plagiarism ††††

†††† Rainsford, M., Palmer, M. A., Sauer, J. D., Beeton, N. J., Paine, G., & Hollins, T. (under review). Blurred lines: Why music composition is highly susceptible to unconscious plagiarism. *Submitted May 11, 2017, to Journal of Experimental Psychology: General.*

**Abstract**

Unconscious plagiarism occurs when another person's idea is remembered as one's own. In verbal tasks, the role of idea elaboration in plagiarism has been extensively tested (Stark & Perfect, 2006, 2008; Stark et al., 2005) with the finding that plagiarism is increased by improving other's ideas, but not by imagery. We investigated whether the same mechanisms influence plagiarism in music. Further, we investigated the effects of domain-relevant expertise on plagiarism. In two experiments using an established three-stage paradigm, expert and non-expert musicians generated eight-note melodies with a computer partner. A proportion of the melodies were then elaborated within-subjects by improvement and imagery. A control group of melodies were not re-presented following generation. Following a retention interval (one day or one week), participants completed recall and recognition tests, and generated new melodies. Contrary to expectations, all forms of elaboration increased plagiarism in comparison to control melodies. Thus, re-exposure to ideas, regardless of task, increases the likelihood of plagiarism in music. No effect of expertise on plagiarism was detected in any task. The result is considered in context of the literature on explicit and implicit memory. Musical knowledge is predominantly acquired implicitly through exposure (Rorhmeier & Rebuschat, 2012). According to the source monitoring framework, where implicit memory is primarily employed, source monitoring processes may not necessarily be engaged. As these findings show that musicians are more susceptible to plagiarism than previously thought, policy-makers may need to consider the degree to which a musician is held responsible for unconscious plagiarism.

**Keywords:** unconscious plagiarism, music, idea elaboration,

source monitoring, expertise

"Good artists copy, great artists steal."

- Attributed to T. S. Eliot, Igor Stravinsky,

Pablo Picasso, Steve Jobs, and others (O'Toole, 2013).

Unconscious plagiarism occurs when a person generates an idea believing that it is original, when in fact it has been retrieved from memory (Brown & Murphy, 1989). In law, no distinction is made between cases of unconscious and deliberate copying: Both are deemed unauthorized derivative works (Müllensiefen & Pendzich, 2009). Despite the frequency of such cases involving high-profile musicians (Cason & Müllensiefen, 2012), no empirical studies have investigated the cognitive mechanisms involved in the unconscious plagiarism of music.

A three-stage paradigm has been used extensively to study plagiarism in verbal creative tasks (Brown & Murphy, 1989; Marsh & Bower, 1993; Stark et al., 2005). In the *Generation* phase of the paradigm, participants work as a group, taking turns to generate solutions to a creative task, such as the Alternate Uses Test (e.g., "List as many alternate uses for a brick that you can think of"; Christensen, Guilford, Merrifield, & Wilson, 1960). Participants subsequently work alone to recall their own ideas (*Recall-own*) and generate new solutions to the same task (*Generate-new*). Plagiarism is defined as reproducing another participant's idea in either of the latter two phases.

Stark et al. (2005) explained the plagiarism elicited using this paradigm in terms of Johnson, Hashtroudi, and Lindsay's (1993) source monitoring framework as a form of source confusion in discriminating internal from external events. Source judgments are not made directly, but inferred through the evaluation of contextual information associated with memory retrieval (Johnson et al., 1993). Internally generated ideas may be associated with the recall of imaginal or cognitive processes, whereas external events are associated with greater sensory, temporal, and spatial detail (Johnson & Raye, 1981). Where information associated with internal and external sources is highly similar, source monitoring errors increase, and others' ideas are increasingly likely to be recalled as one's own (Landau & Marsh, 1997).

If unconscious plagiarism reflects the confusion of internal and external sources, elaborating on others' ideas should increase the likelihood that externally experienced ideas are later recalled as one's own, because idea generation and improvement would be recalled as highly similar cognitive events (Perfect & Stark, 2008a). Under real world conditions, writers or artists frequently elaborate on and rework ideas, affording the opportunity for ideas retrieved from memory to be incorporated as one's own.

Stark and colleagues (2005; Stark & Perfect, 2008) tested this proposal by asking participants to elaborate ideas following the Generation phase of the paradigm. Two forms of elaboration were used, *imagery*, where participants imagine an initial idea and rate its quality (e.g., how effective is a brick used as a doorstop?), and *improvement*, where participants suggest ways in which an initial idea may be improved (e.g., improving a brick used as a doorstop by painting it). Both forms of elaboration increased correct recall to the same degree, but imagining others' ideas did not increase plagiarism, because the cognitive processes involved in imagery and idea generation differ considerably. In contrast, improvement considerably increased plagiarism, supporting the proposal that idea improvement is the key cognitive mechanism by which others' ideas are confused as one's own (Stark et al., 2005). Improving others' ideas gives rise to cognitive processes that are involved in idea generation (e.g., adding features that reflect personal knowledge from one's own experience). When the idea is recalled later, if it is accompanied by memory for these generative cognitive processes, this will increase the chance that the idea is deemed one's own (Stark & Perfect, 2006; Stark et al., 2005).

It is important to note that although improvement of other's ideas consistently increases plagiarism in recall-own tasks, it has not been shown to affect plagiarism in generate-new tasks. This is because source monitoring processes are only involved in the recall-own task, where the participant must both recall earlier-suggested ideas, as well as discriminate their own contributions from others'. When generating new ideas, one must only decide whether an idea is new or should be rejected as previously encountered; the source of the idea does not matter (Stark et al., 2005). A dissociation is therefore normally observed between factors increasing recall-own and generate-new plagiarism (Macrae et al., 1999; Perfect et al., 2009).

We applied this paradigm to music composition to investigate whether these findings generalize. Does improving someone else's melody increase the risk of unconsciously plagiarizing that melody when participants recall their own compositions, generate new melodies, and attempt to discriminate their own from others' melodies in a recognition task?

**Domain Expertise and Plagiarism**

We also investigated whether domain-relevant expertise moderates the effects of elaboration on unconscious plagiarism; that is, would musical expertise make someone more or less likely to unconsciously plagiarize melodies? Previous research on unconscious plagiarism has examined the effects of expertise in terms of how the expertise of the source of an idea (i.e., the person who generated the idea) affects the likelihood that the idea will be unconsciously plagiarized. This work has demonstrated that ideas from experts and high-credibility sources are more likely to be unconsciously plagiarized during a generate-new task than ideas from non-experts and low-credibility sources (Bink et al., 1999; Perfect et al., 2009). In contrast, we consider how unconscious plagiarism might be influenced by the expertise of the person attempting to recall an idea or generate a new idea (in this case, recalling a previously-heard melody or generating a new melody). This issue is especially important because accusations of unconscious plagiarism made in court tend to be levelled at musicians with considerable expertise. Thus, it is critical to develop an understanding of the extent to which expertise can shape the propensity to plagiarize. For example, if musical expertise does (or does not) affect the propensity to unconsciously plagiarize music, then this can be taken into account when considering the extent to which a composer should be held accountable for copyright infringements.

No studies have yet tested the effects of domain-relevant expert memory on unconscious plagiarism using the three-stage paradigm, or in music composition. However, there is reason to expect that musical expertise will reduce the likelihood of plagiarism. Experts recognize and recall domain-relevant information better than non-experts (e.g., Chase & Simon, 1973; Hunt & Rawson, 2011) as novel information is better integrated into existing schemata (Castel et al., 2007). In music, trained musicians' improved discrimination of distinctive information enables them to recognize known melodies faster than non-musicians (Bailes, 2010). Consistent with these ideas, Dow (2015) found that Masters level scientists plagiarized less than first year undergraduates from visual and verbal examples provided before a divergent thinking test, as they had a greater cohort of possible solutions available in memory.

Although Dow's (2015) results suggest that expert musicians should be better able to discriminate their own ideas from others' in a three-stage paradigm experiment, this cannot be assumed. When considered in the broader context of the false memory literature, evidence for the role of expert memory is mixed. DRM paradigm studies have shown that the same improvements to organization and activation of domain-relevant schemata which facilitate domain-relevant expertise can increase false memory errors in experts (Castel et al., 2007; Patihis et al., 2013). Patihis and colleagues (2013) also found that individuals with highly superior autobiographical memory were as susceptible to the misinformation effect as normal controls.

We therefore examined whether expert musicians, defined as having ten or more years of intensive training (Ericsson et al., 1993), would be more or less likely than non-expert musicians to plagiarize. Based on Dow's (2015) findings in a study of unconscious plagiarism, together with the improved discrimination of domain relevant-information shown by experts (Chase & Simon, 1973; Hunt & Rawson, 2011), we predicted that expert musicians would plagiarize less than non-experts. However, Dow (2015) showed that while expertise reduced plagiarism, experts were still susceptible to unconscious plagiarism. Thus, we did not expect expertise to eliminate plagiarism altogether.

**Summary and hypotheses**

We tested whether the cognitive processes underpinning unconscious plagiarism in verbal tasks also influence unconscious plagiarism in music composition. Based on the proposal that improvement of others' ideas increases source confusion (Stark & Perfect, 2007, 2008; Stark et al., 2005), we hypothesized that melodies elaborated by improvement (cf. imagery and control melodies) would be more vulnerable to plagiarism in the recall-own phase, and in a recognition test. Although a reliable effect of elaboration has not been found in verbal generate-new plagiarism, consistent with previous research, we also tested for these effects in the generate-new task, as we expected to observe a dissociation between factors increasing recall-own and recognition plagiarism (which involve source-monitoring processes) and generate-new plagiarism (Perfect et al., 2009). Finally, we predicted that expert musicians would plagiarize less than non-expert musicians, due to the effects of skilled knowledge in improving recall and discrimination between items (Bailes, 2010; Hunt & Rawson, 2011).

# Experiment 1

## Method

### Participants

Thirty-six participants (aged 18-67 years; *M* = 26.5, *SD* = 8.4) comprised 18 expert musicians and 18 non-expert musicians. Expert musicians had either (a) received a minimum of 10 years of intensive training, or (b) passed the entry examination for the Tasmanian Conservatorium of Music. Expert musicians had received a mean of 10.8 years training (*SD* = 5.2 years), non-experts had received a mean of 4.1 years training (*SD* = 2.5 years). Expert musicians had played music for a mean of 18.9 years (SD = 9.7 years); non-experts had played for a mean of 11.3 years (SD = 8.4 years). Participants received course credit or monetary payment for participating.

Participants were naïve to the purposes of the experiment, but told that the study was about music cognition in creative tasks. After the second day of testing, participants were fully debriefed.

**Materials**

Participants completed all tasks using the MUSOS Toolkit (Rainsford, Palmer, & Paine, 2016). This software was designed using Max/MSP (Cycling ’74, 2014a) to replicate common memory paradigms with musical stimuli. The full software and stimulus set used in both experiments is provided online at http://www.soundinmind.net/data/UPProgram.zip.

Melodies are presented using *step-sequencers*, a device which displays musical notes as square blocks within a table, with the X-axis representing time and the Y-axis representing pitch. Participants compose and edit melodies by clicking within the table to place the blocks in position, and click a button to audition the melody and record it to disk. A piano sound was used for output so as to provide a pleasant but neutral timbre.

Each melody composed by participants was 8 notes in length, with uniform rhythm. Melodies were composed on a non-western modal scale (*maqam kurd* in Arabic music, also known as the *Phrygian mode* in medieval music) to reduce the possibility of intrusions from melodies known to the participants. To provide some context for composing melodies, participants were given a randomly selected four line excerpt from a classical Arabic poem (Al-Busairi, 2005), and instructed to compose and elaborate on the melodies according to their interpretation of the poem’s theme.

The 24 computer-generated melodies used in the tasks were drawn from a database of melodies composed during pilot testing. Melodies were analysed prior to inclusion in the experiment to ensure that the degree of similarity between any two melodies was no greater than chance (*opti3* < 0.4), using the application SIMILE (Müllensiefen & Frieler, 2006a).

**Procedure**

**Session one: Generation and Elaboration phases.** Testing was conducted in two sessions each lasting one hour, separated by a 24-hour retention interval (Brown & Halliday, 1991).

For the Generation phase, participants used the step-sequencer to compose their own melodies and to listen to the computer-generated melodies. Participants composed one melody, and then listened to three melodies composed by the computer (analogous to a group of four people taking turns to compose melodies)[‡‡‡‡]. A total of 24 melodies were generated, six by the participant and 18 by the computer. These melodies were then assigned in counterbalanced order to the three Elaboration conditions—Improvement, Imagery, and Control—with eight melodies in each condition (two from the participant and six from the computer).

Participants were randomly allocated to first elaborate melodies by either Imagery or Improvement task. For the Imagery task, participants were presented with the melodies in random order and rated each in response to the statement "This melody reflects the mood of the poem as I interpret it" on a seven-point Likert-type scale, where -3 indicated "strongly disagree", 0 indicated neither agreement or disagreement, and +3 indicated "strongly agree".

For the Improvement task, participants were presented with a further eight melodies in random order. Participants were instructed to modify a minimum of four notes from each melody, to improve the melody to better suit the poem. Melodies assigned to the Control condition were not re-presented or modified during the Elaboration phase.

[‡‡‡‡] No inter-stimulus interval or noise mask was used between melodies.

**Session two: Recall-own and Generate-new phases, and Recognition task.** Participants were presented with the poem they had read on the previous day, and asked to re-read the poem and to consider again the mood and musical ideas that it evoked.

For the Recall-own phase, participants were given six empty step-sequencers, and attempted to recall and enter the melodies they composed in the Generation task. Participants were given unlimited time to complete the task, and were instructed to make their best attempt if they could not recall the whole melody.

For the Generate-new phase, participants were given six empty step-sequencers, and composed six new melodies, again focusing on representing the theme of the poem in music.

For the Recognition task, participants were presented with a selection of 24 melodies in random order. These comprised all 18 of the computer-generated melodies from the Generation phase (six each from the Improvement, Imagery and Control conditions), three of the participant's own melodies from the Generation phase, and three new melodies that had not been heard during the experiment. The proportions of own, computer-generated, and new melodies followed that used by Stark and Perfect (2007).

Participants listened to each melody and provided ratings in response to two statements. Ratings were made on a seven-point Likert-type scale (where -3 indicated "strongly disagree", 0 indicated neither agreement nor disagreement, and +3 indicated "strongly agree"). Participants first rated whether the melody was familiar, as a response to the statement "I have heard this melody before in this experiment". Then, as a measure of source memory, participants rated whether the melody was their own or a computer-generated melody, as a response to the statement “This melody is one that I composed”.

Participants then completed a brief questionnaire on their level of musical experience, before being debriefed as to the true purpose of the experiment.

**Design and data analysis**

**Recall-own and Generate-new phases.** Following Stark et al. (2005), data from the Recall-own and Generate-new phases were analysed separately. Data analysis for both phases followed a 2 (Expertise: Expert, Non-expert) × 3 (Condition: Improvement, Imagery, Control) mixed factorial design.

In contrast to verbal creative tasks, where plagiarism can only involve identical reproduction of another person’s idea (Stark et al., 2005), plagiarism cases in music often involve instances where only a subsection of the melody matches another composition, but is too similar to have been originally composed (Müllensiefen & Pendzich, 2009). Computational methods are increasingly used in the laboratory to measure musical similarity, as these are capable of capturing more subtle instances where a melody may be partially reproduced with transformations (Müllensiefen & Wiggins, 2011).

To measure plagiarism in the Recall-own and Generate-new tasks, we used the *opti3* algorithm from the application SIMILE (Müllensiefen & Frieler, 2006a). This algorithm measures the degree of similarity of pitch, harmonic and rhythmic content, and is designed to identify similar melodies within a large collection (Müllensiefen & Frieler, 2006b). Scores on the measure range from 0 to 1 (with 1 indicating a 100% match with another melody). Values above 0.4 are considered too similar to have occurred by chance (Müllensiefen & Frieler, 2007), and were thus counted as plagiarised.

***Correct recall.*** We compared the participant melodies from the Recall-own phase against the participant-generated melodies from the Generation phase, and counted the number of matches in each condition at a level above chance (*opti3* > 0.4).

***Unconscious plagiarism.*** We compared the participant melodies from the Recall-own and Generate-new phases against all of the computer-generated melodies from the Generation phase, and counted the number of matches against the computer-generated melodies at a level above chance (*opti3* > 0.4) in each condition.

In music, it is possible for a musician to draw on two separate sources (see Kreps, 2009). Pilot testing revealed that it was likewise possible for a participant's melody to partially match segments from two melodies in separate elaboration conditions. Where this occurred, we counted both matches.

We used several additional methods to cross-check the effectiveness of the *opti3* algorithm in measuring Recall-Own and Generate-New plagiarism in participant melodies, details of which are described in the supplementary materials accompanying this paper.

**Recognition task.** For the Recognition task, ratings of Familiarity and Source were analysed separately. A 2 (Expertise: Expert, Non-expert) × 5 (Condition: Participant-generated, Improvement, Imagery, Control, New) design was used for analyses of Familiarity and Source respectively. Only computer-generated melodies were included in the three elaboration conditions (Improvement, Imagery, Control).

**Power analysis.** A priori power calculations were conducted using G*Power 3.1 (Faul, Erdfelder, Lang, & Buchner, 2009). We based power calculations on the analyses for the recognition test. These indicated that a sample size of 32 would provide sufficient power (> 0.95) to detect a medium sized interaction effect of $f$ = 0.25 in a 2x5 mixed factorial ANOVA.

## Results

Participants experienced intrusions at a level above chance in all tasks. All participants generated at least one melody that matched a computer-generated melody at a level above chance (*opti3* > 0.4) in the Recall-own task, and only 3 participants did not produce a melody that matched a computer-generated melody in the Generate-New task. In the Recognition task, inspection of source ratings for individual participants revealed that 34 of the 36 participants (94.4%) plagiarised by identifying at least one computer-generated melody as their own, with a rating of 1 ("somewhat agree") or greater. No differences in plagiarism were detected between Expert and Non-expert musicians in any task ($F$ values < 1.24, $p$ values > .29).

### Recall-own phase

**Correct recall.** Of the 216 melodies generated by participants, only 7 were recalled in full (*opti3* = 1.0), although 89 of the recalled melodies (41.20%) matched at least one of the participant's melodies from the Generation phase at a level above chance (*opti3* > 0.4).

Across all conditions, participants produced a mean of 3.6 matches ($SD$ = 3.6) against one of their own melodies from the Generation phase at a level above chance. The mean number of melodies recalled in each condition by experts and non-experts is provided in the upper section of Table 4.1. Correct recall was not affected by condition, expertise status, or the interaction between these terms ($F$ values < 1, $p$ values > .48). To investigate whether any evidence of elaboration on correct recall might be found, we conducted paired samples t-tests comparing the effects of elaboration on correct recall in comparison to control melodies, which further confirmed that the differences between conditions were negligible. These analyses are included in the supplementary analyses.

**Unconscious plagiarism during recall.** Means for the number of matches against a computer-generated melody in each condition appear in the central section of Table 4.1. As partial intrusions may occur from more than one melody, we counted all significant matches (*opti3* > 0.4) across conditions, resulting in a maximum of up to six matches in each condition (although this would be highly unexpected).

Table 4.1.

*Mean (SD) Number of Melodies Correctly Recalled, and Mean Melodies Plagiarized in Each Condition in the Recall-own and Generate-new Phases of Experiment 1.*

| | Elaboration condition | | | |
|---|---|---|---|---|
| | Improvement | Imagery | Control | Total |
| *Recall-own Phase* | | | | |
| *Correct recall* | | | | |
| Expert | 1.5 (1.8) | 1.2 (1.3) | 1.2 (1.4) | 3.9 (3.6) |
| Non-expert | 1.3 (1.5) | 1.0 (1.2) | 1.1 (1.8) | 3.4 (3.7) |
| Overall | 1.4 (1.6) | 1.1 (1.2) | 1.1 (1.6) | 3.6 (3.6) |
| *Unconscious plagiarism* | | | | |
| Expert | 1.1 (1.2) | 1.4 (1.3) | 1.3 (1.0) | 3.8 (1.8) |
| Non-expert | 1.0 (1.1) | 1.1 (1.1) | 1.3 (1.2) | 3.3 (1.8) |
| Overall | 1.1 (1.1) | 1.2 (1.2) | 1.3 (1.1) | 3.6 (1.8) |
| *Generate-new Phase* | | | | |
| *Unconscious plagiarism* | | | | |
| Expert | 1.2 (1.2) | 0.8 (1.0) | 0.8 (0.7) | 2.8 (1.6) |
| Non-expert | 1.1 (1.1) | 0.9 (0.7) | 0.6 (0.6) | 2.6 (1.5) |
| Overall | 1.1 (1.1) | 0.9 (0.9) | 0.7 (0.7) | 2.7 (1.5) |

Evidence of unconscious plagiarism was found in all conditions, with at least one melody plagiarized in each condition. However, the level of plagiarism did not vary with the elaboration manipulation, expertise status, or the interaction ($F$ values $< 1$, $p$ values $> .47$). A lack of an effect of elaboration on recall-own plagiarism was unexpected in comparison to the literature (Stark & Perfect, 2006, 2008; Stark et al., 2005). To investigate whether any effect of elaboration on recall-own plagiarism might be found, we further conducted paired samples t-tests examining the effect of elaboration to control melodies which confirmed negligible differences following both improvement and imagery. These analyses are included in the supplementary materials.

The lack of an effect of elaboration on recall-own plagiarism differs from prior results with verbal materials (Stark & Perfect, 2006, 2008; Stark et al., 2005), perhaps reflecting the difficulty of recalling six newly composed melodies, as opposed to recalling alternate uses for objects. As Stark and Perfect (2007) demonstrated unconscious plagiarism with both recall and recognition, we focused on the results of the Recognition test in this and the following experiment as a more sensitive measure of participants' ability to discriminate their own from the computer-generated melodies.

**Generate-new phase**

Although no complete copies of the computer-generated melodies were produced, statistically significant matches (*opti3* > 0.4) were found in all conditions. Plagiarism was highest for both groups in the improvement condition, and lesser in the imagery and control conditions. The mean number of matches against a computer-generated melody in each condition is provided in the central section of Table 4.1.

A 2 (Expertise: Expert, Non-expert) × 3 (Condition: Improvement, Imagery, Control) mixed factorial ANOVA revealed no significant main effects or interactions ($F$ values < 1.93, $p$ values > .16). As for the Recall-own phase, we then conducted paired samples t-tests between the elaboration conditions and the control condition, to examine whether the data supported any effect of elaboration on plagiarism.

These indicated some influence of elaboration on Generate-New plagiarism. Following improvement, melodies were plagiarised significantly more often than control melodies, with a small to medium effect observed, $t(35) = 2.12$, $p = .041$, 95% CI [0.02, 0.82], $d = 0.46$. Imagined melodies were also plagiarised more often than control melodies, but this difference was not significant, although a small effect was found, $t(35) = 1.03$, $p = .310$, 95% CI [-0.16, 0.50], $d = 0.22$. Improved melodies were plagiarised more often than imagined melodies, although this difference was also not significant, but again a small effect was found, $t(35) = 0.95$, $p = .347$, 95%CI [-0.28, 0.78], $d = 0.25$.

**Recognition task**

Given the novelty of our stimuli, and that this was the first application of the three-stage paradigm to music, we first conducted brief analyses which confirmed that, overall, participants were able to discriminate old from new melodies ($F(1, 34) = 81.85$, $p < .001$, $\eta_p^2 = 0.71$), and their own from others' melodies ($F(1, 34) = 190.79$, $p < .001$, $\eta_p^2 = .0.85$). Details of these tests are provided in the supplementary analyses.

**Familiarity ratings.** To examine the effects of elaboration on familiarity for melodies, we conducted a 2 (Expertise: Expert, Non-expert) × 5 (Condition: Participant-generated, Improvement, Imagery, Control, New) mixed factorial ANOVA on participant familiarity ratings, using Greenhouse-Geisser corrections where appropriate. Figure 4.1 (panel A) shows mean familiarity scores for melodies in each condition.

The omnibus test revealed a significant main effect of condition on familiarity with melodies, $F(3.08, 104.54) = 62.15$, $p < .001$, $\eta_p^2 = 0.65$. No further effects were significant ($F$ values < 1.80, $p$ values > .19). We further examined the effect of each condition on familiarity using Bonferroni-corrected pairwise comparisons.

***Elaborated melodies.*** To investigate the effect of elaboration on familiarity, we compared the computer-generated melodies which had been elaborated with the control melodies. Critically, elaborated melodies in all three conditions were rated more familiar than control melodies. These differences represented large effects. On average, melodies subject to improvement received familiarity ratings 0.77 points higher than control melodies, 95% CI [0.32, 1.22], $SD = 0.90$, $p <.001$, $d = 0.85$. Melodies subject to imagery received familiarity ratings 0.82 points higher than control melodies, 95% CI [0.32, 1.32], $SD = 1.00$, $p <.001$, $d = 0.79$. Familiarity ratings did not differ between the improvement and imagery conditions ($p = 1.0$).

***Own, others, and new melodies.*** We then examined the overall pattern of familiarity ratings across own, others' and new melodies. Familiarity ratings were highest for participants' own melodies ($p$s < .001) and lowest for the new melodies ($p$s < .002). The computer-generated melodies from the Generation phase were significantly less familiar than participants' own melodies, and as discussed above, familiarity was greater for melodies that had been elaborated than the control melodies, which were not re-presented ($p$s < .001, see Figure 4.1, panel A). However, although the comparisons between the control condition and elaborated melodies provided clear evidence that familiarity increased when melodies were re-presented to the participant, regardless of task, the comparisons between participant-generated melodies and other conditions warrant closer consideration. These comparisons were confounded by participants elaborating their own melodies (i.e., the participant-generated melodies included some that were elaborated and some that were not). To test whether elaboration increased familiarity for own melodies, we conducted a 2 (Expertise: Expert, Non-expert) × 3 (Condition: Improvement, Imagery, Control) mixed factorial ANOVA, which showed no effect of elaboration on familiarity with own melodies ($F < 1$, $p > .41$, further details of this analysis are available in the supplementary materials). Thus, the observed increase in familiarity for own melodies was not due to the effects of elaboration alone.

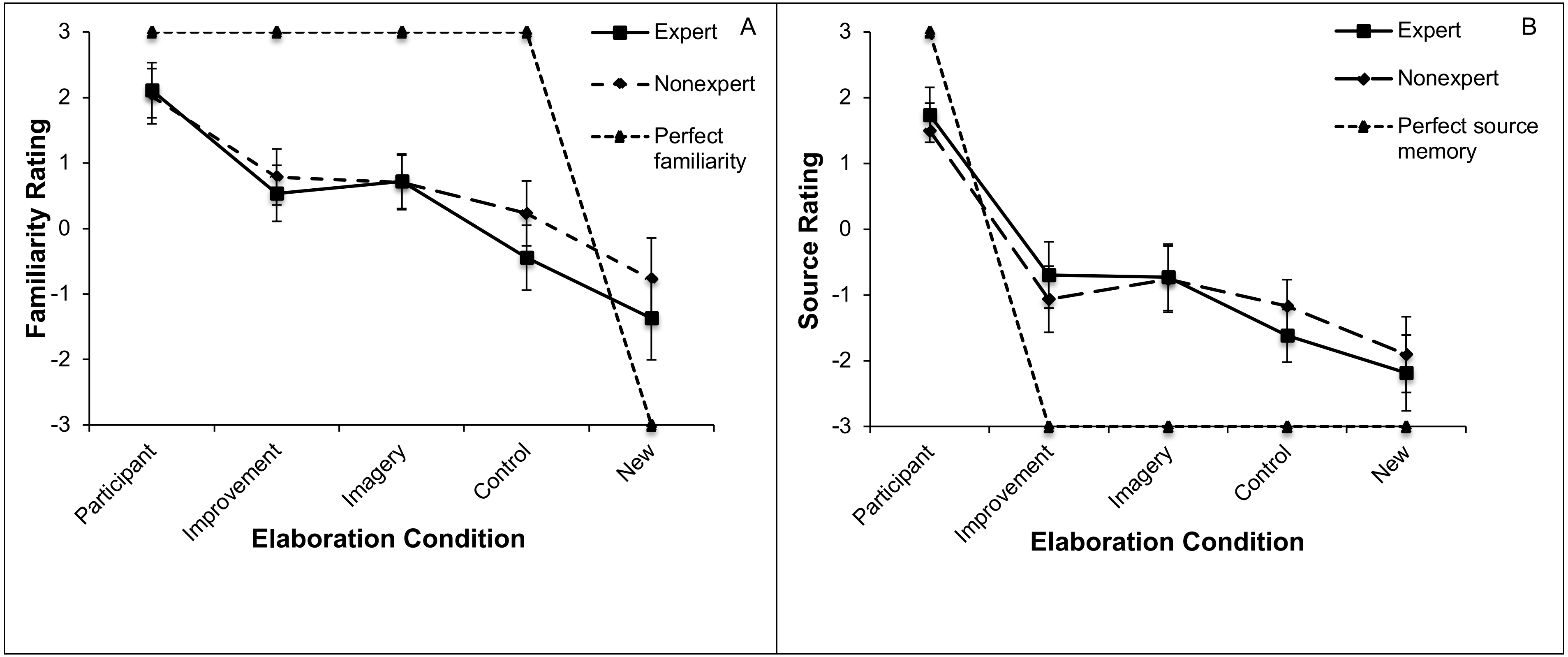


*Figure 4.1.* Familiarity and Source recognition scores in Experiment 1 are shown in Panels A and B respectively. The dotted line indicates perfect familiarity and source memory respectively. Participants identified their own melodies and the novel melodies accurately, but melodies which were elaborated were rated as more familiar, and were also more likely to be rated as being the participant's own. No differences were observed between expert and non-expert musicians in either test (Error bars denote 95% confidence intervals).

**Source ratings.** We then tested the effects of elaboration on source memory. Figure 4.1 (panel B) shows mean source ratings for melodies in each condition. A 2 (Expertise: Expert, Non-expert) × 5 (Condition: Participant-generated, Improvement, Imagery, Control, New) mixed factorial ANOVA on Source ratings revealed a significant main effect of condition, $F(3.38, 114.87) = 80.30$, $p < .001$, $\eta_p^2 = .70$. No further effects were significant ($F$ values < 1.30, $p$ values > .29). We then used Bonferroni-corrected pairwise comparisons to further examine the effect of each condition on source memory.

***Unconscious plagiarism during source recognition.*** The critical comparisons for understanding source confusion were between the computer-generated melodies which had been elaborated and the control condition. Similar to participant familiarity ratings, melodies that had been elaborated were rated higher than control melodies, indicating that participants were more likely to confuse these melodies as their own (see Figure 4.1, panel B). On average, melodies subject to improvement received source ratings 0.52 points higher than control melodies, 95% CI [0.002, 1.03], $p = .048$, $d = 0.47$. Melodies subject to imagery received source ratings 0.65 points higher than control melodies, 95% CI [0.11, 1.19], $p = .009$, $d = 0.79$. Source ratings did not differ between the improvement and imagery conditions ($p = 1.0$).

Elaboration of melodies by either improvement or imagery therefore resulted in significant increases in both familiarity and in plagiarism (i.e., claiming computer-generated melodies as one’s own), with no difference in effect between these conditions. In contrast to the findings of Stark et al. (2005), where only improvement increased plagiarism, this result suggests that re-exposure to ideas, regardless of task, increases plagiarism in music.

***Own, others, and new ideas.*** We further examined the same Bonferroni-corrected comparisons to compare source ratings for participant's own, elaborated, and new melodies. These followed a similar pattern to familiarity ratings, with participant's own melodies rated significantly higher than all other melodies (all *p*s < .001) and new melodies significantly lower than all other melodies (all *p*s < .045). Thus, participants were most accurate in discriminating their own melodies and novel melodies, but source confusion was greater in the computer-generated conditions (see Figure 4.1 panel B).

Although the comparisons between elaborated and control melodies provide strong evidence of unconscious plagiarism, as mentioned in the analysis of familiarity, the comparisons between participant- and computer-generated melodies require further examination because participants were required to elaborate a proportion of their own melodies. To test whether elaboration affected participant source memory for their own melodies, we conducted a 2 (Expertise: Expert, Non-expert) × 3 (Condition: Improvement, Imagery, Control) mixed factorial ANOVA on source ratings of the participants' melodies. This revealed no main effects or interactions, indicating that elaboration did not affect source memory for own melodies ($F$ values < 1.3, $p$ values > .27). Thus, the increased accuracy shown when participants recognised their own melodies was not merely due to the effects of elaboration or re-presentation.

Across both the Generate-New and Recognition tasks, participants plagiarised in both the improvement and imagery conditions, an effect that was not expected based on previous studies in verbal tasks. Although only improvement resulted in a statistically significant increase in Generate-new plagiarism, a small effect of imagery was also found. In the Recognition test, improvement and imagery both increased plagiarism; in addition, participants demonstrated significantly greater familiarity with melodies that they were more likely to claim as their own. Taken together with the consistent lack of a difference between imagery and improvement across tasks, the results of Experiment 1 provide initial support for an exposure effect in music, as increased exposure to a melody, regardless of the task involved, increased plagiarism.

## Experiment 2

We conducted a second experiment to replicate Experiment 1 with several modifications aimed at providing a stronger test of whether both imagery and improvement increase plagiarism in music (as suggested by the results of Experiment 1). First, we manipulated retention interval. Given that longer intervals can enhance the effects of improvement on unconscious plagiarism (Perfect et al., 2011), we compared the original delay of 24 hours between the first and second sessions with an interval of one week.

Second, we included an additional version of the improvement manipulation (*Improvement-Extension)* which required participants to extend melodies by adding eight notes. Stark and colleagues (2005) operationalized improvement as a form of decoration, meaning the original idea was retained in memory alongside the suggested improvements. For example, when improving the idea of a brick used as a doorstop by covering it with wallpaper (Stark et al., 2005), the original concept of using a brick as a doorstop is retained in memory, and may potentially be mistaken as one's own idea. In contrast, modifying notes from an original melody may overwrite the original memory trace (Williamson et al., 2010). We retained the improvement condition used in Experiment 1 (renamed *Improvement-Modification*), and introduced *the Improvement-Extension* condition, which aligned more closely with Stark and colleagues' (2005) task.

Third, in the Recognition task, we altered the experimental software to eliminate the possibility that visual recognition may have influenced task performance. We replaced the step-sequencer (which displays melodies as a grid) with a progress bar which indicated to the participant when playback of the melody had finished.

Finally, we omitted the Recall-own phase during session two to simplify the design. We retained the familiarity and source recognition tasks and the Generate-new task.

## Method

### Participants

Sixty-five participants (34 females), aged between 18 and 74 years (*M* = 32.4 years, *SD* = 17.0 years), took part in Experiment 2. Of these, 31 were classified as expert musicians using the same criterion as for Experiment 1. Expert musicians had received a mean of 10.4 years training (*SD* = 5.7 years), non-experts had received a mean of 2.9 years training (*SD* = 2.7 years). Expert musicians had played music for a mean of 30.8 years (*SD* = 19.6 years); non-experts had played for a mean of 7.1 years (*SD* = 7.7 years).

Participants were randomly assigned to complete the second session of the study following a 24-hour (15 Expert, 18 Non-expert) or 1 week (16 Expert, 16 Non-expert) retention interval.

Participants who were undergraduate students in Psychology at the University of Tasmania received course credit for participation. All other participants were reimbursed for their time and travel costs.

**Materials and Procedure**

The materials used were identical to those in Experiment 1, with the computer program modified to include the additional manipulation of elaboration (*Improvement-Extension*). For this task, the original melody was presented at the beginning of a sixteen-note sequence, followed by eight blank spaces. Participants were asked to leave the first eight notes intact and extend the melody by an additional eight notes, again focusing on improving the melody to better suit the theme of the poem provided.

**Session 1: Generation and Elaboration phases.** Due to the increased number of experimental conditions, we increased the number of melodies to be generated so that a proportional number of melodies could be allocated to each condition. In the Generation phase, eight melodies were contributed by the participant, and 24 melodies by the computer, for a total of 32 melodies. Of these, a counterbalanced selection of six computer-generated and two participant melodies were allocated to the each of the elaboration conditions of *Improvement-Modification, Improvement-Extension, and Imagery.* A further six computer-generated and two participant melodies were allocated to the Control condition. Participants were randomly allocated to complete the three elaboration tasks in one of six possible orders.

**Session 2: Generate New phase and Recognition task.** Participants first completed the Generate New phase, and then the Recognition test. For the Generate New phase, participants were presented with the poem which they had read in Session 1, and were asked to create eight new melodies.

The Recognition task comprised 36 melodies. These included all 24 of the computer-generated melodies from the Generation phase, six of the Participant’s own melodies, and six novel melodies. In each condition (Participant-generated, Improvement: Modification, Improvement: Extension, Imagery, Control, New) six melodies were presented. Again, participants were not informed which phase of the experiment the melodies were taken from, but were told that the melodies could have come from either the first or second session.

Finally, participants completed a questionnaire on their level of music experience and music listening habits, and were debriefed.

**Power analysis**

We conducted a priori power calculations using G*Power 3.1 (Faul et al., 2009). As for Experiment 1, we based power calculations on the analyses for the recognition test. These indicated that a sample size of 40 would provide sufficient power (> 0.95) to detect a medium sized interaction effect of $f = 0.25$ in a 2x2x6 mixed factorial ANOVA.

## Results

As for Experiment 1, substantial evidence of source confusion was found in all tasks. In the Generate-New task, all participants produced at least one melody that matched a computer-generated melody at a level above chance (*opti3* > 0.4). Likewise, in the Recognition task, all participants claimed with some degree of confidence that at least one computer-generated melody was their own. Across tasks, no effects of expertise on plagiarism were found ($F$ values < 1, $p$ values > .72).

**Generate-New phase**

We excluded data for 12 participants due to an issue with corrupted melody storage in the program databases, resulting in 53 participants (25 expert, 28 non-expert) completing the Generate-New task. We excluded one participant melody as anomalous due to it producing significant matches against all 24 computer-generated melodies. Two participants (one expert, one non-expert) had one computer-generated melody excluded from comparisons as they had missed these trials in the generation phase, and three participants (two expert, one non-expert) entered only seven melodies instead of eight in the generate-new task.

As for Experiment 1, no complete copies of computer-generated melodies were produced, but statistically significant matches (*opti3* > 0.4) were found in all conditions.

To examine the effects of elaboration on plagiarism, we conducted a 2 (Expertise: Expert, Non-expert) × 2 (Time: 1 day, 1 week) × 4 (Condition: Improvement-Modification, Improvement-Extension, Imagery, Control) ANOVA. The mean number of intrusions experienced by expert and non-expert musicians from the computer-generated melodies are given in Table 4.2. The three-way interaction was not significant ($F < 1$, $p > .58$), however, a moderate interaction between condition and expertise, $F(2.85, 139.45) = 3.00$, $p = .033$, $\eta_p^2 = .06$, suggested that expert musicians plagiarised more often from the improvement-modification condition, whereas non-experts experienced a greater number of intrusions from the imagery condition. However, the main effect of expertise was not significant ($F < 1$, $p > .90$), thus, the two groups did not differ overall in levels of plagiarism. We also found a significant moderate main effect of condition, $F(2.85, 139.45) = 4.03$, $p = .009$, $\eta_p^2 = .08$, but the main effect of time was not significant ($F < 1$, $p > .84$).

Table 4.2.

*Mean (SD) Number of Melodies Plagiarized In Each Condition in the Generate-new Phase of Experiment 2.*

| | Elaboration condition | | | | |
|---|---|---|---|---|---|
| | Improvement-Extension | Imagery | Improvement -Modification | Control | Total |
| Expert | 1.56 (1.19) | 1.40 (1.04) | 1.76 (1.42) | 0.76 (1.05) | 5.48 (2.49) |
| Non-expert | 1.46 (1.10) | 1.93 (1.36) | 1.07 (1.39) | 1.11 (0.92) | 5.57 (2.95) |
| Overall | 1.51 (1.14) | 1.68 (1.24) | 1.40 (1.43) | 0.94 (0.99) | 5.53 (2.71) |

We conducted paired samples t-tests comparing each of the three elaboration conditions against the control condition, to further examine the effect of elaboration on unconscious plagiarism. All contrasts against the control condition revealed small-to-moderate effects, although only the imagery condition remained significant following a Bonferroni correction to $\alpha = .008$. The increased plagiarism following imagery, compared to control melodies, represented a moderate effect, $t(52) = 4.02$, $p < .001$, 95% CI [0.37, 1.10], $d = 0.66$. Likewise, improvement-extension moderately increased plagiarism compared to the control condition, $t(52) = 2.56$, $p = .014$, 95% CI [0.12, 1.01], $d = 0.53$. A small-to-moderate increase in plagiarism was detected following improvement-modification compared to control, $t(52) = 1.88$, $p = .065$, 95% CI [-0.03, 0.94], $d = 0.37$. No differences between elaboration conditions were detected (all *p*s > .25).

Thus, when the Generate-New test was replicated in a larger sample, the results followed a similar pattern to those found in the Recognition task in Experiment 1. Re-exposure to ideas, regardless of elaboration task, increased unconscious plagiarism when attempting to compose new music. An effect of exposure on Generate-New plagiarism is a novel finding in comparison to studies in verbal domains, where only effects of subjective evaluation (partner expertise and item quality) have been found to increase generate-new plagiarism (Bink et al., 1999; Perfect et al., 2009; Perfect & Stark, 2008b).

**Recognition task**

We excluded data from 9 participants due to an issue with corrupted melody storage in the program databases, resulting in 56 participants (26 expert, 30 non-expert) completing the Recognition task. Two participants (one expert, one non-expert) had one computer-generated melody excluded from the recognition task as they had missed these trials in the generation phase. As for Experiment 1, we first confirmed that participants were able to discriminate old from new melodies ($F(1, 54) = 66.88$, $p < .001$, $\eta_p^2 = 0.55$), and their own from others melodies ($F(1, 54) = 75.80$, $p < .001$, $\eta_p^2 = 0.58$). Details of these tests are provided in the supplementary analyses.

**Familiarity ratings.** To test the effects of elaboration on familiarity for melodies, we conducted a 2 (Expertise: Expert, Non-expert) x 2 (Time: 24 hours, 1 week) × 6 (Condition: Participant-generated, Improvement-Modification, Improvement-Extension, Imagery, Control, New) mixed factorial ANOVA on familiarity ratings, which revealed no significant interactions ($F$ values < 1.4, p values > .26). Figure 4.2 (panel A) shows mean familiarity scores for each condition. Examining simple main effects, we found a moderate effect of expertise, $F(1, 52) = 5.31$, $p = .025$, $\eta_p^2 = 0.09$. Experts indicated significantly less familiarity with earlier-heard melodies than non-experts, although this was only by a mean difference of 0.41 points, $SD = 1.34$, 95%CI [0.05, 0.77], $p = .025$, $d = 0.62$. In the absence of a significant interaction effect, this suggests that experts employed a more conservative decision criterion across all conditions (including their own items), a result consistent with previous demonstrations of conservative decision-making in expert samples across domains (Lueddeke & Higham, 2011; Thompson, Tangen, & McCarthy, 2013).

We also found a large main effect of condition on familiarity, $F(3.99, 207.27) = 30.91$, $p < .001$, $\eta_p^2 = 0.37$. We used Bonferroni-adjusted pairwise comparisons to further examine this finding.

***Elaborated melodies.*** The effects of elaboration in comparison to control melodies were similar to that found in the previous experiment, with participants showing significantly greater familiarity with melodies after all types of elaboration in comparison to control melodies (see Figure 4.2, panel A). These differences represented moderate effects. On average, melodies subject to improvement-modification received familiarity ratings 0.50 points higher than control melodies, 95%CI [0.07, 0.92], $SD = 1.03$, $p = .011$, $d = 0.51$. Melodies subject to improvement-extension received familiarity ratings 0.64 points higher than control melodies, 95% CI [0.27, 1.02], $SD = 0.91$, $p < .001$, $d = 0.73$, and melodies subject to imagery received ratings 0.44 points higher than control melodies, $SD = 1.00$, $p = .028$, 95% CI [0.03, 0.85], $d = 0.55$. As for Experiment 1, familiarity ratings did not differ significantly between any of the elaboration conditions (all $ps > 0.82$).

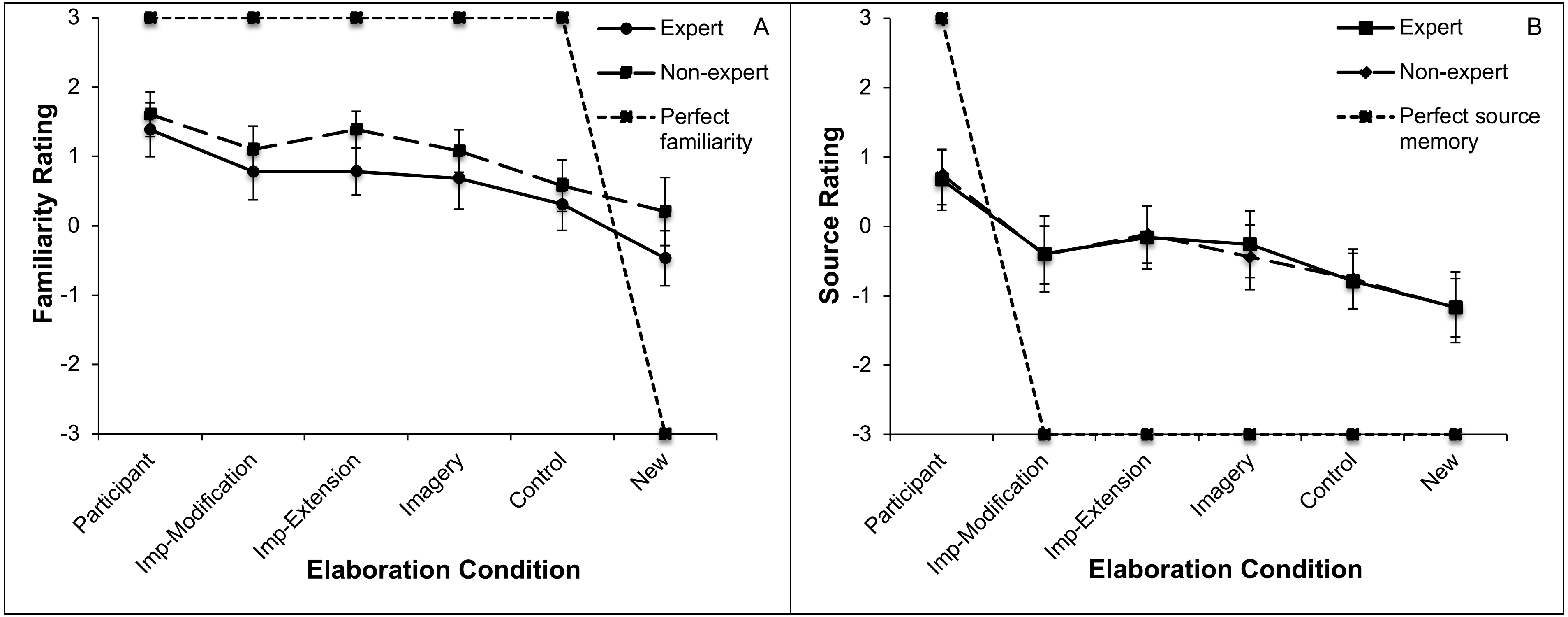


*Figure 4.2.* Familiarity and Source recognition scores in each condition for Experiment 2 are shown in Panel A and B, with the dotted line indicating perfect familiarity and perfect source memory respectively. Again, melodies rated as more familiar were also more likely to be rated as being the participant's own. While experts rated their familiarity with melodies more conservatively than non-experts, no differences in source ratings were observed between experts and non-experts. (Error bars denote 95% confidence intervals).

***Own, others, and new melodies.*** Consistent with Experiment 1, all participants demonstrated significantly greater familiarity with their own melodies than the computer-generated melodies (*ps* < .035). New melodies were also significantly less familiar than computer-generated and own melodies (*ps* < .002), and as discussed above, melodies which had been elaborated were more familiar than control melodies (see Figure 4.2, panel A). As for Experiment 1, due to the analysis being confounded by participants elaborating their own melodies, we conducted a 2 (Expertise: Expert, Non-expert) × 2 (Time: 24 hours, 1 week) × 4 (Condition: Improvement-Modification, Improvement-Extension, Imagery, Control) mixed factorial ANOVA, which revealed that elaboration did not affect familiarity with own melodies, ($F < 1.84$, $p > .14$, further details of this analysis are included in the supplementary materials). Thus, the increase in familiarity for own melodies was not simply due to elaboration, but represented an additional effect of ownership of ideas.

**Source ratings.** To test for the effects of elaboration on source memory, we conducted a 2 (Expertise: Expert, Non-expert) × 2 (Time: 24 hours, 1 week) × 6 (Condition: Participant-generated, Improvement-Modification, Improvement-Extension, Imagery, Control, New) mixed factorial ANOVA. The three-way interaction of expertise, condition, and time revealed a small, but non-significant effect, $F(4.59, 238.55) = 2.05$, $p = .078$, $\eta_p^2 = 0.04$. While this indicated that experts and non-experts plagiarised from different conditions, overall, no interaction effects were found, and the main effects of expertise and time were not significant ($F$ values < 1.08, $p$ values > .37).

We found a large effect of condition, $F(4.59, 238.55) = 32.56$, $p < .001$, $\eta_p^2 = 0.39$. Using Bonferroni-corrected pairwise comparisons to further examine this result, we found significant differences between all conditions (*ps* < .05 using a Bonferroni contrast), with the exception of the three elaboration conditions.

***Unconscious plagiarism.*** The critical comparisons for understanding plagiarism were between the computer-generated melodies that had been elaborated and the control melodies. On average, participants rated melodies subject to improvement-modification 0.37 points higher than control melodies, a difference that was not significant, but represented a small effect, 95%CI [-0.09, 0.83], $SD = 1.12$, $p = .260$, $d = 0.32$. However, a significant moderate increase in ratings of 0.63 points in the improvement-extension (cf. control) condition indicated that in this condition, melodies were more likely to be claimed as the participants' own, 95% CI [0.20, 1.07], $SD = 1.04$, $p = .001$, $d = 0.58$. Melodies subject to imagery were also rated significantly higher than control melodies, by an average of 0.42 points, representing a small-to-moderate effect, 95%CI [0.01, 0.84], $SD = 1.02$, $p = .045$, $d = 0.37$. No differences were observed between the three elaboration conditions (all *ps* = 1.0).

Thus, as for Experiment 1, when recognising melodies, participants were more likely to plagiarise by claiming the computer-generated melodies were their own in conditions where melodies were re-presented to the participant, regardless of elaboration task. No difference in effect was observed between elaboration conditions, and this increase in source memory errors was again accompanied by an increase in familiarity ratings in the same conditions (see Figure 4.2, panel B).

***Own, others, and new melodies.*** Further examination of the same Bonferroni-corrected comparisons between conditions showed that, as for Experiment 1, participants gave significantly higher ratings to their own than the computer-generated melodies in all conditions (all *p*s < .001, and significantly lower ratings to new than computer-generated melodies (all *p*s < .001), except for the control condition ($p < .085$, see Figure 4.2 panel B). Although this analysis is confounded by participants elaborating their own melodies, two aspects of our data speak against elaboration inflating participant source ratings of their own melodies. First, recognition of own melodies did not differ between the elaborated and control melodies. To examine this, we conducted a 2 (Expertise: Expert, Non-expert) × 2 (Time: 24 hours, 1 week) × 4 (Condition: Improvement-Modification, Improvement-Extension, Imagery, Control) mixed factorial ANOVA, which showed no effect of condition on source ratings of participant's own melodies, $F < 0.13$, $p > 0.94$ (further details of this analysis are provided in the supplementary materials). Second, if recognition of own melodies was influenced only by elaboration, no difference would be observed between participants' own and the computer-generated melodies which had been elaborated. In contrast, moderate-to-large increases were observed in all conditions, the smallest of which was 0.83 points, between participant-generated and imagery melodies, 95%CI [0.30, 1.36], $p < .001$, $d = 0.75$). Therefore, the increased accuracy that participants showed when recognising their own melodies cannot be explained by elaboration alone, and must be due to additional factors associated with ownership of ideas.

Thus, when Experiment 1 was replicated in a larger sample, the same pattern of effects was found in both the Generate-New and Recognition tests. Re-exposure to melodies, regardless of elaboration task, increased both unconscious plagiarism when composing original music, as well as source memory errors when attempting to discriminate one's own ideas from those of others'. This proposal was further supported by the corresponding increase in familiarity ratings in both experiments following re-exposure. Critically, for an exposure effect, no significant differences were detected between the three elaboration conditions. In both the Generate-New task and the Recognition test, the effect of improvement-modification on plagiarism was weaker than the effects of imagery and improvement-extension, suggesting that although this form of elaboration does increase the risk of plagiarism to some extent due to re-exposure, modification of the melody altered the trace of the item in memory.

In contrast to the robust effect of improvement on verbal plagiarism found by Stark and colleagues (2005), these findings in music appear to accord with an earlier strength-based model of plagiarism proposed by Marsh and Bower (1993). According to this model, as strength in memory increases, an initial threshold is reached at which an item judged to be old, rather than new. A further threshold is set at the point in which own items, which are the strongest in memory, are discriminated from others' ideas. While further research is needed to determine the degree to which elaboration and ownership contribute to recognition of own melodies, our study shows a similar pattern of results. Melodies that were more familiar to the participant were also more likely to be rated as the participant's own, and new melodies were the least familiar. Where melodies were re-presented to the participant for elaboration, a corresponding increase in memory strength and plagiarism occurred.

## General Discussion

We investigated whether the mechanisms identified as contributing to plagiarism in verbal tasks lead to source confusion in music composition. When participants attempted to recall or recognise their own ideas, and when generating new ideas, substantial plagiarism from the computer-generated melodies occurred. While no participants plagiarised a melody in full, note-perfect recall of music is rare (Müllensiefen & Wiggins, 2011). Using computational measures, we were able to identify significant partial intrusions, as observed in real-world plagiarism cases (Cason & Müllensiefen, 2012).

Contrary to expectations, no effect of expertise was detected in any task. This result contrasts with Dow's (2015) findings that expert scientists plagiarise less in divergent thinking tasks, further demonstrating differences between music plagiarism versus other domains. However, as only two studies have now investigated the role of expert memory in plagiarism, further research is needed to examine whether expert memory affects plagiarism across domains. Our findings are more consistent with those from the broader literature of false memory, where experts have been found to be at least equally, if not more susceptible to false memory effects as non-experts (Castel et al., 2007; Patihis et al., 2013). Musicians, both expert and non-expert, appear to be highly susceptible to unconscious plagiarism following any form of interaction with others' ideas.

The patterns of findings in the present studies do not replicate those seen in prior research on unconscious plagiarism in the verbal domain. To recap, that work shows that: 1) recall-own plagiarism and source-monitoring errors are increased specifically by improvement of an idea and not by imagery (Perfect & Stark, 2008a, 2012; Stark & Perfect, 2007; Stark et al., 2005); 2) that plagiarism during a generate-new task is increased by the positive valence or quality of the idea, not by elaboration (Bink et al., 1999; Perfect et al., 2009; Perfect & Stark, 2008b). Neither pattern was observed here with musical materials. With respect to recall, Experiment 1 failed to find any effect of elaboration in the recall-own task. For recognition, both studies showed a general effect of elaboration on recognition rather than a specific effect of improvement. With respect to the Generate-New task, both studies demonstrated that any form of elaboration led to higher levels of plagiarism. Thus, we did not observe the dissociation between generate-new and recognition plagiarism expected from previous studies (Perfect et al., 2009; Stark & Perfect, 2007); in both tasks, re-exposure increased music plagiarism.

These findings are of particular significance for theoretical accounts of unconscious plagiarism, because they demonstrate that the cognitive processes underpinning plagiarism differ between music and verbal ideas. Whereas plagiarism of verbal ideas occurs through confusion of contextual source traces, in particular after improving others' ideas, plagiarism of music seems to be based on re-exposure to material generated by others. Our familiarity data offer further support for this idea. Across both studies, familiarity and source ratings produced strikingly similar patterns: Participants' own and new melodies were discriminated well, but items in all elaboration tasks were rated as more familiar than control ideas, and were more likely to be plagiarized. Critically, no differences were observed between elaboration type; all forms of re-exposure increased both familiarity with and plagiarism of melodies. Plagiarism in music is therefore influenced by different factors to the source monitoring processes involved in verbal plagiarism.

Marsh and Bower (1993) proposed a strength-based model of unconscious plagiarism, based on Johnson and Raye's (1981) description of reality monitoring. According to this model, the participant sets a decision criterion where items that are the strongest in memory are assumed to be their own. Items that do not reach this criterion are assumed to be generated by others, with a further decision criterion set below this as a point where items are sufficiently unfamiliar to be assumed to be new. This model was not supported in verbal studies of elaboration, where strength in memory was demonstrated to be equivalent for both imagined and improved ideas, despite inflated levels of plagiarism in the improvement condition (Stark et al., 2005). However, in music, where plagiarism occurs through exposure, this may result in those items achieving sufficient strength in memory to cross the threshold at which items are decided to be one's own, a proposal supported in this experiment by the corresponding increases in familiarity and plagiarism from re-exposed melodies.

While this model explains our data from the recognition task, strength in memory should reduce plagiarism when generating new ideas, as memory strength would allow the participant to correctly reject an idea as earlier-generated (Marsh & Bower, 1993; Stark et al., 2005). Although the effect does not always reach significance, elaboration by both imagery and improvement increases memory strength, and thus have been shown to reduce the likelihood of generate-new plagiarism in verbal studies by 30-42%[§§§§] (Perfect & Stark, 2012; Stark & Perfect, 2007, 2008; Stark et al., 2005). Our data from the generate-new task show further differences between musical and verbal plagiarism, as the same pattern of results was found to the recognition test, with re-exposure via all forms of elaboration again increasing plagiarism. Here our results may potentially show some consistency to those from verbal studies, where liking for ideas increases generate-new plagiarism (Bink et al., 1999; Perfect et al., 2009; Perfect & Stark, 2008b). Music has been associated with a strong *mere exposure effect* (Zajonc, 1968), where repeated exposure increases both memory strength and liking for items. In music, the mere exposure effect is particularly powerful; liking and memory for melodies is increased after a single listen (Peretz et al., 1998; Stalinski & Schellenberg, 2013). While an

[§§§§] This range estimate is based upon comparison of control vs elaboration conditions in unconscious plagiarism during the generate-new task in previous experiments involving a single elaboration phase involving imagination, improvement or control. The data come from the following experiments: Stark, Perfect and Newstead (2005: Experiments 1 and 2), Stark and Perfect (2007), Stark and Perfect (2008: Day 1 elaboration condition only), Perfect and Stark (2012: Experiments 1 and 2, self-relevant conditions only).

exposure-based effect appears paradoxical in the generate-new task, the most parsimonious explanation for our findings lies in the mere exposure effect. If re-exposure increases both memory strength and liking, consistent with findings in verbal tasks, participants may have plagiarised those melodies which they liked better.

Indeed, music is predominantly implicitly learned via exposure (Rohrmeier & Rebuschat, 2012). According to the source monitoring framework, this reliance on implicit memory may undermine source monitoring which depends on the explicit, elaborative processing of contextual information (Johnson et al., 1993). If musical knowledge is predominantly acquired implicitly, this would further explain the lack of an effect of source confusion via improvement in the recognition task, as those processes would be evident only via explicit acquisition.

The factors which improve explicit and implicit memory are known to be dissociated. Explicit memory is improved by elaborative processing, whereas implicit memory is not affected by depth of processing, but by priming, i.e. increased exposure (Schacter & Church, 1992; Schacter & McGlynn, 1989). Further, these systems compete for resources (Virag et al., 2015). According to Johnson and Raye (1981), source monitoring involves both decision processes (such as Marsh & Bower's decision criterion) and evaluation of contextual memory traces (as investigated by Stark and colleagues). The role of these processes in unconscious plagiarism appears to depend on whether the task involved primarily relies on explicit, elaborative processing, or implicit exposure.

As this is the first examination of Brown and Murphy's (1989) paradigm using a musical task, some limitations of the present adaptation need to be addressed. Although we chose in this experiment to use a recognition task due to improved reliability, further understanding of the mechanisms underpinning recall-own plagiarism in music is needed. We asked participants to compose a melody with isochronic rhythm to simplify measurement, and because the majority of court cases focus on melodic similarity (Müllensiefen & Pendzich, 2009). Although this is common in laboratory studies, the task is somewhat artificial for a musician. As the rhythmic and timbral components of a melody affect memory (Hébert & Peretz, 1997; Schellenberg & Habashi, 2015), investigation of these factors in unconscious plagiarism would create a more ecologically valid setting for a musician.

Stark and Perfect (2008) considered correct source monitoring of verbal ideas to be difficult—if not impossible—after extended idea improvement. With music, the risk of plagiarism seems even greater: Our results show that musicians are highly susceptible to unconscious plagiarism following only brief re-exposure to an idea. Given that musicians cannot avoid exposure to music, future research must focus on reducing the risk of unconscious plagiarism, and policymakers need to consider the degree to which a musician is held responsible when plagiarism occurs unconsciously.

## Context

Unconscious plagiarism is a serious issue affecting a musician's livelihood, yet little scientific understanding presently informs court decisions on music plagiarism. In verbal tasks, Hollins and colleagues have found that unconscious plagiarism primarily occurs through improvement of others' ideas (Stark & Perfect, 2006, 2008; Stark et al., 2005). We developed this study as a conceptual replication of their experiments using musical stimuli, to test their proposal that improvement might be the mechanism by which musicians incidentally incorporate others' ideas into their own work (Perfect & Stark, 2008a). The role of domain-relevant expertise in plagiarism has also received little attention, yet plagiarism by an expert musician frequently results in public shaming (Macrae et al., 1999). We therefore also tested whether domain-relevant expert memory influences plagiarism. Our findings from two studies show that musicians are more vulnerable to unconscious plagiarism than previously thought. Plagiarism in music increases through exposure, regardless of task, thus, no single task can be avoided to reduce the risk of plagiarism. Expert musicians were no less likely than non-experts to plagiarise. These results have implications for the legal handling of unconscious plagiarism cases, as unintentional copying is treated in the same way as deliberate copying under copyright law.

## Supplementary analyses

## Experiment 1

### Recall-own phase

**Correct recall.** We conducted paired samples t-tests to examine differences in correct recall between participant melodies which had been elaborated, and control melodies. These revealed a negligible increase in correct recall of melodies following improvement, $t(35) = 1.20$, $p = .238$, 95% CI [-0.17, 0.67], $d = 0.16$, and a negligible reduction in correct recall following imagery, $t(35) = -1.0$, $p = .923$, 95% CI [-0.61, 0.55], $d = 0.02$.

**Unconscious plagiarism.** We conducted paired samples t-tests to examine the effects of elaboration on unconscious plagiarism in comparison to control melodies. These revealed a small, but non-significant reduction in plagiarism following improvement, in comparison to control melodies, $t(35) = -0.76$, $p = .453$, 95% CI [-0.82, 0.37], $d = 0.20$. Although plagiarism was also lesser in melodies that had been imagined in comparison to control melodies, this difference represented a negligible effect, $t(35) = -0.20$, $p = .846$, 95% CI [-0.63, 0.52], $d = 0.05$.

### Recognition task

Given the novelty of our stimuli, and that this was the first application of the three-stage paradigm to music, we first conducted a series of brief analyses to ensure that participants could discriminate old from new, and their own from others' ideas accurately.

**Familiarity ratings.** We conducted a 2(Source: Old, New) × 2(Expertise: Expert, Non-expert) mixed factorial ANOVA to test whether participants could distinguish old from new stimuli on the recognition test. Descriptive statistics for expert and non-expert musicians are provided in the upper section of Table 4.3. For

Old melodies, we took the mean of all previously encountered melodies (Participant, Improvement, Imagery, Control). A significant main effect of source indicated that participants were, overall, able to discriminate old from new melodies, $F(1, 34) = 81.85$, $p < .001$, $\eta_p^2 = 0.71$. No further main effects or interactions were observed ($F$ values < 2.13, $p$ values > .154).

Table 4.3.

*Mean (SD) Familiarity Ratings Collapsed Across Old and New Melodies, and Mean (SD) Source Ratings Collapsed Across Own and Others' Melodies In Experiment 1.*

| | Condition | |
|---|---|---|
| *Familiarity* | Old | New |
| Expert | 0.73 (0.69) | -1.37 (1.37) |
| Non-expert | 0.94 (0.56) | -0.78 (1.27) |
| Overall | 0.83 (0.63) | -1.07 (1.34) |
| *Source* | | |
| Expert | 1.74 (0.78) | -1.31 (0.80) |
| Non-expert | 1.50 (0.96) | -1.22 (0.67) |
| Overall | 1.62 (0.87) | -1.27 (0.73) |

**Source ratings.** As for familiarity ratings, we first tested whether participants could, overall, distinguish their own melodies from those generated by the computer, using a 2(Source: Participant, Computer) × 2(Expertise: Expert, Non-expert) mixed factorial ANOVA. Descriptive statistics for expert and non-expert musicians are provided in the lower section of Table 4.3. For the Computer melodies, we took the mean of participant ratings in all computer-generated conditions (Improvement, Imagery, Control, New). The significant main effect of source, $F(1, 34) = 190.79$, $p < .001$, $\eta_p^2 = .0.85$, confirmed that, overall, participants were able to discriminate their own melodies from the computer-generated melodies. No further main effects or interactions were observed ($F$ values < 0.61, $p$ values > .44).

**Own melodies**

**Familiarity.** We conducted a 2 (Expertise: Expert, Non-expert) × 3 (Condition: Improvement, Imagery, Control) mixed factorial ANOVA on participant familiarity ratings for their own melodies. We found a significant interaction of condition and expertise, $F(1.93, 65.47) = 4.47$, $p = .016$, $\eta_p^2 = 0.12$, however, the main effects of condition and expertise were not significant ($F$ values < 0.9, $p$ values > .41). Thus, while experts and non-experts reported greater familiarity with different elaboration conditions, no effect of elaboration on familiarity with own melodies was evident.

**Source.** As reported in the main analyses, we conducted a 2 (Expertise: Expert, Non-expert) × 3 (Condition: Improvement, Imagery, Control) mixed factorial ANOVA on source ratings for participants' own melodies. No main effects or interactions were significant ($F$ values < 1.3, $p$ values > .27), thus, elaboration did not affect source memory for participants' own melodies.

**Experiment 2**

**Recognition task**

**Familiarity ratings.** To confirm that participants could perform the task reliably, as for Experiment 1 we first conducted a 2(Source: Old, New) × 2(Expertise: Expert, Non-expert) mixed factorial ANOVA. Descriptive statistics for expert and non-expert musicians are given in the upper section of Table 4.4. This analysis revealed a significant main effect of source, $F(1, 54) = 66.88$, $p < .001$, $\eta_p^2 = 0.55$, confirming that participants were able to discriminate old from new melodies. A significant main effect of expertise, $F(1, 54) = 5.70$, $p = .020$, $\eta_p^2 = 0.10$, indicated that non-experts indicated significantly greater familiarity with melodies than expert musicians in all conditions, although this was only by a mean difference of 0.52 points (95%CI [0.08, 0.95], $p = .020$, $d = 0.45$). No interaction effects were found ($F = 1.35$, $p = .251$).

Table 4.4.

*Mean (SD) Familiarity Ratings Collapsed Across Old and New Melodies, and Mean (SD) Source Ratings Collapsed Across Own and Others' Melodies In Experiment 2.*

| | Condition | |
|---|---|---|
| *Familiarity* | Old | New |
| Expert | 0.79 (0.75) | -0.47 (0.98) |
| Non-expert | 1.15 (0.56) | 0.21 (1.32) |
| Overall | 0.98 (0.68) | -0.11 (1.21) |
| *Source* | Own | Others |
| Expert | 0.67 (1.09) | -0.55 (1.00) |
| Non-expert | 0.71 (1.05) | -0.58 (0.87) |
| Overall | 0.69 (1.06) | -0.57 (0.92) |

**Source ratings.** As for Experiment 1, we first tested participants' ability to distinguish their own melodies from the computer-generated melodies overall, using a 2(Source: Participant, Computer) × 2 (Expertise: Expert, Non-expert) mixed factorial ANOVA. Descriptive statistics for expert and non-expert musicians are given in the lower section of Table 4.4. This analysis revealed a significant main effect of source, $F(1, 54) = 75.80$, $p < .001$, $\eta_p^2 = 0.58$, indicating that participants could discriminate their own ideas from those generated by the computer. No other significant effects were found ($F$ values < 0.04, $p$ values > .83). Thus, the results of the analyses investigating the effects of elaboration on source ratings represent genuine source memory errors, and not merely the result of participant inaccuracy across all conditions.

**Own melodies**

**Familiarity.** We conducted a 2 (Expertise: Expert, Non-expert) × 2 (Time: 24 hours, 1 week) × 4 (Condition: Improvement-Modification, Improvement-Extension, Imagery, Control) mixed factorial ANOVA on familiarity ratings for participant's own melodies. The main effect of time was moderate, but non-significant, $F(1, 52) = 3.22$, $p = .079$, $\eta_p^2 = 0.06$. Bonferroni-corrected pairwise comparisons revealed that, overall, participants were more familiar with their own melodies after 1 week than after 24 hours, by a mean difference of 0.47 points, 95%CI [-0.06, 1.00], $d = 0.48$. The interaction of expertise and time also showed a moderate, but non-significant effect, $F(1, 52) = 3.81$, $p = .056$, $\eta_p^2 = 0.07$. Bonferroni-corrected pairwise comparisons revealed that expert musicians experienced a large increase in familiarity with their own melodies after 1 week in comparison to 24 hours, by a mean difference of 0.98 points, 95% CI[0.23, 1.73], $p = .013$, $d = 1.06$, whereas the difference in retention interval did not affect non-expert musicians ($p = .912$).

We found a significant interaction of condition and time, which showed that participants indicated greater familiarity with melodies from different elaboration conditions over time, $F(2.85, 148.13) = 3.00$, $\eta_p^2 = 0.06$. However, no further main effects or interactions were significant, ($F$ values < 1.84, $p$ values > .14). Thus, while the factors influencing familiarity with own melodies were complex, and varied over time, elaboration did not affect familiarity for participants' own ideas.

**Source ratings.** To investigate the effects of elaboration on source memory for own melodies, we conducted a 2 (Expertise: Expert, Non-expert) × 2 (Time: 24 hours, 1 week) × 4 (Condition: Improvement-Modification, Improvement-Extension, Imagery, Control) mixed factorial ANOVA on source ratings of the participants' melodies, taking the mean rating in each condition. We found a significant main effect of time, $F(1, 52) = 4.06$, $p = .049$, $\eta_p^2 = 0.07$. Pairwise comparisons revealed a similar pattern to the familiarity ratings, showing that participants were more likely to correctly recognise their own melodies after one week than after 24 hours, by a mean difference of 0.58 points, 95% CI [0.002, 1.16], $p = .049$, $d = 0.54$. No further main effects or interactions were significant ($F$ values < 1.67, $p$ values > .20). As discussed in the main analyses, no evidence was found for elaboration condition increasing participant memory for their own melodies ($F < 0.13$, $p > 0.94$).

## Alternative computational measures of Generate-New plagiarism

We used several additional methods to cross-check the effectiveness of the *opti3* algorithm for measuring Generate-New plagiarism in participant-generated melodies. The first was by audition: Two trained musicians listened to a random selection of the melodies and made judgments based on audible similarity. Melodies were chosen at random from those melodies which produced low (*opti3* = 0.4-0.5) and high (*opti3* > 0.6) levels of similarity when compared to the computer-generated melodies. The judges listened first to the original and then the computer-generated melody, and rated categorically whether the similarity was clearly audible or not.

These judgments aligned well with the *opti3* results, with the *opti3* algorithm producing statistically significant matches at both low and high values where the level of similarity between melodies was audible. However, there were some false positive matches, where the level of similarity was less clear to the listener, although a logical musical explanation for the result could still be found.

We also reanalysed the results using an alternative algorithm (*raw edit distance*; Müllensiefen & Frieler, 2006b), and also with custom significance levels for both the *opti3* and *raw edit distance* algorithms based on the cohort of melodies used in the experiment (according to the method described by Müllensiefen and Frieler (2007)). These additional analyses revealed a similar pattern of results to the original *opti3* analyses, but lead to an exclusion of audibly similar matches at low values of the algorithm. Thus, we reported the findings of the initial *opti3* analyses in this study as the most accurate description of the level of intrusion experienced by participants. These small but statistically significant matches would best be described as a degree of musical influence from the computer-generated melodies into the generation of original music. However, such instances of influence are important because cases of musical copyright infringement commonly involve these types of intrusions, where the melodic sequence reproduced is not identical, but is too similar to have occurred by chance (Müllensiefen & Pendzich, 2009). Although our analyses indicate that the *opti3* algorithm provides a valid index of overlap between melodies, further research may well develop more refined measures of plagiarism in music.

# Chapter 5: Study 4

## Unconscious plagiarism in music: Testing an intervention to reduce plagiarism*****

***** Rainsford, M., Palmer, M. A., & Sauer, J. D. (2017, manuscript in preparation). Unconscious plagiarism in music: Testing an intervention to reduce plagiarism.

**Abstract**

Unconscious plagiarism in music occurs via exposure, therefore musicians are at risk of plagiarism simply through listening. Given that the risk to musicians is so great, it is important to test an intervention to reduce plagiarism. Based on distractor tasks from word-list studies (Glanzer & Cunitz, 1966), we developed a music-listening distractor task designed to interfere with recent listening experiences, and thus reduce memory for recently-heard items. We tested the intervention during the retention interval of a common three-stage paradigm used to study plagiarism. Participants listened to the intervention either a) at the end of the first session of the study, after generating and elaborating ideas, or b) at the beginning of the second session, prior to generating new ideas, and completing a recognition test. A control group completed the three-stage paradigm without receiving the intervention. Results showed atypical patterns to previous studies in music. Plagiarism occurred in all conditions, but idea elaboration did not influence plagiarism in any group when generating new melodies. When recognizing melodies, in contrast to previous studies where all forms of elaboration increased plagiarism, across groups, only idea improvement increased plagiarism relative to control. However, no evidence was found to support a reduction in plagiarism due to the intervention.

**Keywords:** unconscious plagiarism, source monitoring, music, intervention, exposure

Unconscious plagiarism occurs when a person intends to generate an original idea, and while doing so, retrieves a previously encountered idea from memory (Brown & Murphy, 1989). Plagiarism cases attract considerable attention in the media, with perhaps the best known concerning the melody of George Harrison's song "My Sweet Lord" (*Bright Tunes Music Corp v Harrisongs Music Ltd.*, 1976), which was found to be highly similar to that of The Chiffon's "He's So Fine", a song that at the time had received considerable radio airplay (Müllensiefen & Pendzich, 2009). Although Harrison was unconscious of reproducing the melody, to the extent of testifying that his composition was original, the court found that he had retrieved the melody from memory, misattributing the source as his own (Perfect & Stark, 2008a). Unconscious reuse of material does not qualify for copyright exceptions under *fair use* provisions, and so Harrison was required to pay royalties to The Chiffons (Müllensiefen & Pendzich, 2009). Given the increasing frequency of plagiarism cases involving high-profile musicians (USC Gould School of Law, 2012), it is important to develop and test a cognitive intervention aimed at reducing the risk of unconscious plagiarism.

A number of studies have elicited unconscious plagiarism in the laboratory using a simple three-stage paradigm (e.g., Brown & Murphy, 1989; Marsh & Bower, 1993; Stark et al., 2005). Participants work as a group, or with a computer partner to generate solutions to a creative task in turn (*generation* phase). Following a retention interval, participants return to recall their own ideas (*recall-own* phase) and generate new solutions to the same task (*generate-new* phase). In this paradigm, plagiarism is defined as reproducing another participants' (or the computer's) ideas in either of the latter two tasks. Alternatively, a recognition test of source memory for the participants own, others' and new ideas may be used in place of the recall-own task.

In such a test, plagiarism occurs when another participants' idea is claimed as one's own (Stark & Perfect, 2007).

Studies in the verbal domain have shown that plagiarism during the recall-own phase, and in recognition testing, occurs due to errors in source monitoring (Macrae et al., 1999; Stark & Perfect, 2006, 2007; Stark et al., 2005). The source of an idea is not stored as a direct trace in memory, instead, decision-making processes are used to evaluate qualities of the memory trace in order to attribute the source of an idea (Johnson et al., 1993). Typically, internally-generated ideas are associated with recall of cognitive operations such as idea generation or development, whereas externally-generated ideas are associated with recall of sensory and temporal detail associated with perceiving the idea (Johnson et al., 1993; Johnson & Raye, 1981). Increasing the internal cognitive operations associated with others' ideas, by asking participants to elaborate melodies immediately after idea generation, has been shown to increase the likelihood that a participant will later confuse that idea as their own (Stark & Perfect, 2006, 2008; Stark et al., 2005). Participants are asked to elaborate ideas by suggesting improvements (*improvement*) and imagining and rating the idea (*imagery*). While imagery and improvement result in equivalent depth of processing of the idea, only improvement increased plagiarism when participants were asked to recall or recognize their own ideas (Stark & Perfect, 2007; Stark et al., 2005). Idea generation and improvement involve such similar cognitive operations that participants confuse the improved ideas as their own (Stark & Perfect, 2006, 2008; Stark et al., 2005).

Likewise, when the availability of contextual source traces associated with others' ideas is increased, source monitoring is improved, and plagiarism is reduced. If participants perform the recall-own test with their original partner present, rather than alone, this increases the availability of externally-associated source cues and reduces plagiarism (Hollins et al., 2016; Macrae et al., 1999).

However, the same mechanisms do not explain plagiarism in music. We recently tested the effect of elaboration on musical plagiarism using the three-stage paradigm with a melody generation task. In contrast to verbal tasks, musical plagiarism in both the generate-new and recognition tests was not associated with improvement alone. Instead, plagiarism increased following re-exposure to melodies, regardless of the elaboration task involved (Rainsford et al., under review; see Chapter 4). Further, in verbal tasks, a dissociation is observed between plagiarism in the recall-own task (or recognition testing, Stark & Perfect, 2007), which is increased by improvement, and generate-new plagiarism, which is increased by positive valence of the idea, or idea quality, but not by elaboration (Perfect et al., 2009; Perfect & Stark, 2008b). In music, we did not observe this dissociation, as exposure increased plagiarism in both tasks (Rainsford et al., under review). Although increased memory strength should decrease plagiarism in the generate-new task, because this allows ideas to be better rejected as old (Stark et al., 2005), the *mere exposure effect* (Zajonc, 1968) has been demonstrated to be particularly strong in music, where liking for an idea may increase after a single listen (Peretz et al., 1998). Thus, we proposed that musical generate-new plagiarism, while increased by exposure, is also associated with increased liking for ideas.

The likelihood of plagiarism of a musical idea, either when composing new music or when recognizing own and others' ideas, therefore depends on the strength of the idea in memory (Marsh & Bower, 1993), rather than the presence or absence of contextual source traces. Source monitoring approaches to avoiding plagiarism through contextual reinstatement would therefore be expected to have limited effectiveness in music.

Other methods to reduce plagiarism have focused on real-world approaches, such as admonishing the participant not to plagiarize, and providing financial incentives for not plagiarizing (Stark et al., 2005). Weidler, Multhaup, and Faust (2012) found that increasing accountability, by informing the participant that their responses would be reviewed with the researcher, increased source monitoring, and thus reduced plagiarism. While these forms of instruction were effective in reducing plagiarism, participants did not manage to completely avoid plagiarizing in either study. Plagiarism following extended idea improvement is particularly difficult to avoid; despite instructing participants not to reproduce their own or others' ideas, the likelihood of plagiarism after repeated idea improvement rose to 48% (Stark & Perfect, 2008).

Admonishing writers to avoid plagiarism, and providing incentives to avoid plagiarism by threat of punishment is common practice in universities and the publishing industry, yet this may have a counterproductive effect. Thought suppression has a paradoxical tendency to facilitate activation of the idea being suppressed (Najmi & Wegner, 2008; Wegner, 1994; Wegner, Schneider, Carter, & White, 1987). Participants who were asked to try not to think of a white bear were unable to completely suppress thought of the idea, finding that it occurred at least once per minute, and with increased frequency immediately after thought suppression (Wegner et al., 1987). This occurs because monitoring for a suppressed thought causes the same idea to be held in consciousness (Wegner, 1994; Wegner et al., 1987).

This mechanism may potentially explain the inability of participants in three-stage paradigm studies to avoid plagiarizing, if they tried very hard to avoid thinking of previously-suggested ideas. Focused distraction by thinking of an alternative idea is more effective in reducing the incidence of specific thoughts (Wegner, 2011; Wegner et al., 1987). When participants were asked to think of a red Volkswagen if they happened to think of a white bear, this focused distraction technique successfully reduced the incidence of white bear thoughts (Wegner et al., 1987).

Focused distraction may also offer an approach to reducing plagiarism in music. If plagiarism in music occurs through repeated exposure or priming, rather than confusion of contextual source traces (Rainsford et al., under review), reducing priming of ideas through distraction might be effective in reducing memory for those ideas, and thus plagiarism. To be practical, distraction would need to take place after, rather than during, idea generation, as it would be difficult for a musician to complete a focused distraction task while attending a concert. Glanzer and Cunitz (1966)'s studies of the serial position effect demonstrate that memory for recently-presented words may be reduced through the presentation of a distractor task immediately after study. Distraction must be in the same modality to interfere with phonological short-term stores (Baddeley & Hitch, 1974; Salamé & Baddeley, 1989; Williamson et al., 2010), but an auditory distractor task may be verbal or musical. For example, Petrusic and Jamieson (1978) demonstrated interference with word-list recall by listening to vocal or instrumental music. Listening to music after the generation phase might therefore reduce strength in memory for melodies generated under the three-stage paradigm.

If effective, a musical distractor task could potentially be used by professional musicians to avoid plagiarism. Consideration must therefore be given to the degree to which the task itself might influence a musician's compositional style. If plagiarism in music occurs through exposure, exposure to an interfering melody would be likely to divert participants to plagiarize that melody, instead of the computer-generated melodies used in the study. Therefore, presentation of a melody which is under copyright would be inappropriate as this might cause copyright infringement. However, exposing a musician to a melody that is in the public domain would also be unethical as this might exert an outside influence on the creative process.

In this pilot study, we therefore decided to test the effectiveness of a distractor task consisting of randomly generated musical notes, based on the concept of *white noise*. White noise is sound generated from a random signal, constant in power, across all frequencies audible to the human ear (Mancini, 2002). A musical analogue of white noise might then consist of continuous random presentation of all 12 notes of the Western chromatic scale. Using Max/MSP, we created a device that produced 2 minutes of randomly generated notes ranging from D4 to D5, matching the pitch range which our participants used to compose and listen to melodies under the three-stage paradigm.

We reasoned that listening to musical white noise might provide the benefit of focused distraction from recently-encountered melodies (which should reduce the likelihood of unconscious plagiarism) without itself providing a new melody that could be plagiarised. Although musical white noise has not previously been used as the basis for a focused attention task, research involving focused attention tasks in other modalities provides some evidence that the basic idea is valid. For example, visual white noise has been successfully used as the basis for a focused attention task to reduce the role of visual imagery in food cravings (Kemps & Tiggemann, 2013).

We tested whether the presentation of musical white noise during the three-stage paradigm would reduce plagiarism. Based on interference tasks from verbal recall studies (Glanzer & Cunitz, 1966; Petrusic & Jamieson, 1978), we predicted that listening to an intervention, composed of two minutes of musical white noise during the retention interval of the three-stage paradigm, would reduce plagiarism.

We tested the intervention between-subjects at two stages during the retention interval, a) at the end of the first session after idea generation and elaboration, and b) at the start of the second session of the study, prior to generating new melodies and completing a recognition test. We compared the results of these two groups with a control group who completed the three-stage paradigm without the intervention. While we expected the intervention to be most effective in interfering with newly generated melodies when administered at the end of the first session, it might not always be practical for a musician to listen to an intervention immediately after attending a concert. According to the *generation effect*, memory for self-generated items is greater than memory for others' ideas (Jacoby, 1978). Marsh and Bower (1993) proposed that plagiarism occurs when strength in memory for others' ideas overlaps with that of own ideas, resulting in confusion of others' ideas as one's own. The generation effect is enhanced in delayed recall (Jacoby, 1978), therefore discrimination of own versus others' ideas should be better at the start of the second session of testing. Administration of an interference task at this point may reduce memory for the computer-generated melodies even further. If so, the intervention would become a practical cognitive task that a musician can use at the start of a composition session, to avoid plagiarism.

Although we made no specific prediction regarding the effects of the intervention on elaborated ideas, we retained the manipulations of idea elaboration as previously used in three-stage paradigm studies (Rainsford et al., under review; Stark & Perfect, 2006, 2008; Stark et al., 2005), to investigate whether the task affected memory for melodies differently following elaboration by imagery or improvement.

## Method

### Participants

We recruited participants with a minimum of five years' experience in music-making at any level, either as a professional or amateur musician. The final sample comprised 44 participants (19 male, 25 female), whose ages ranged from 11 – 53 years ($M$ = 28.3, $SD$ = 9.8). Participants had a minimum of 8 and a maximum of 45 years' musical experience ($M$ = 17.3, $SD$ = 8.7). The number of years of musical training that participants had received ranged from 0 to 24 years ($M$ = 9.1, $SD$ = 6.0). Participants were naïve to the purpose of the experiment, and were told that the study was about creativity in music. Following the second session of testing participants were fully debriefed.

### Materials

Participants completed all tasks using the MUSOS Toolkit (MUsic SOftware System; Rainsford et al., 2016). This version of the software was developed in Max/MSP (Cycling '74, 2014a) to replicate the three-stage paradigm used by Brown and Murphy (1989) including the manipulations of elaboration introduced by Stark et al. (2005). The MUSOS Toolkit uses a live.step *step-sequencer* to present melodies to the participant as square blocks within a table with the X axis representing time, and the Y axis representing pitch. Participants compose and edit melodies by clicking and dragging the blocks into place. Each melody was eight notes long, and was composed on a modal scale (*Maqam Kurd*, in Arabic music, or the *Phrygian mode* in medieval music), to avoid intrusion from melodies heard prior to the experimental sessions. Melodies were uniform in rhythm, comprising 8 quarter-notes at 120 bpm.

Participants were given a randomly-selected excerpt from a classical Arabic poem (Al-Busairi, 2005) and were instructed to compose and elaborate melodies to suit the poem.

**Intervention.** The intervention comprised 2 minutes of notes selected at random from the Western chromatic scale, matching the range used to compose melodies (D4 to D5). Rhythm was again uniform, consisting of quarter notes played at the same speed as the melodies (120 bpm). Participants were asked to press the play button and to listen to the music until it finished.

**Procedure**

Testing was conducted in two sessions separated by a 1-week retention interval. The intervention was administered between-subjects, with the Session One group ($n$ = 15) listening to the intervention at the end of the first session following the Generation and Elaboration phases. The Session Two group ($n$ = 15) heard the intervention at the beginning of Session 2, prior to completing the Generate-New and Recognition tasks. A third Control group ($n$ = 14) received no intervention.

**Session one: Generation and Elaboration phases.** The Generation phase was designed to simulate a group of four taking turns to compose melodies. Participants composed one melody for every three generated by the computer, for a total of 32 melodies (8 participant, 24 computer)[†††††].

These melodies were proportionally assigned (2 participant, 6 computer melodies per condition) into three groups of eight melodies which were elaborated in different ways by the participant. A further set of melodies were assigned to a control

[†††††] No inter-stimulus interval or noise mask was used between melodies.

condition, and were not re-presented following idea generation. The three elaboration conditions included *imagery*, and two forms of improvement (*improvement-modification, improvement-extension*). Participants were randomly assigned to complete the elaboration tasks in one of six possible orders.

For the *imagery* task, participants listened to the eight melodies in random order and were asked to rate their response to the statement "This melody reflects the mood of the poem as I interpret it", on a seven point Likert-type scale (-3 indicated "strongly disagree", 0 indicated neither agreement or disagreement, and +3 indicated "strongly agree").

For *improvement-modification*, participants were asked to edit a minimum of four notes to improve the melody so that it better suited the theme of the poem. For *improvement-extension*, participants were asked to add an additional eight notes to the melody, again focusing on improving the melody to better suit the poem.

**Session two: Generate-new phase and Recognition task.** For the Generate-new task, participants were presented with the poem that they had read in the previous session, and were asked to compose a further eight melodies to suit the theme of the poem.

The Recognition task included 36 melodies taken from the Generation phase of the experiment. These comprised six of the participant's own melodies, and all 24 of the computer-generated melodies (6 improvement-modification, 6 improvement-extension, 6 imagery, 6 control) as well as 6 new melodies that had not previously been heard by the participant. Participants were not informed which phase the melodies had been taken from, but were told that the melodies could have come from either session.

Participants were presented with the melodies in random order and asked to provide two ratings using a seven-point Likert-type scale (-3 indicated “strongly disagree”, 0 “neither agree or disagree", and +3 indicated “strongly agree”). Participants rated their familiarity with the melody, in response to the statement “I have heard this melody before in this experiment”, and the source of the melody, in response to the statement “This melody is one that I composed”.

Participants then completed a questionnaire on their musical experience and listening habits and were debriefed.

**Design and data analysis**

**Generate-new phase.** Data analysis followed a 3 (Intervention: Session 1, Session 2, Control) × 4 (Elaboration Condition: Improvement-Modification, Improvement-Extension, Imagery, Control) mixed factorial design.

We used the *opti3* algorithm from the application SIMILE (Müllensiefen & Frieler, 2006a) to identify melodies containing intrusions from the computer-generated melodies. This algorithm measures the degree of similarity between two melodies, taking into account pitch, harmonic, and rhythmic features (Müllensiefen & Frieler, 2006b). The algorithm outputs values ranging from 0 to a maximum of 1 (indicating a 100% match with another melody), with values above 0.4 similar at a level above chance (Müllensiefen & Frieler, 2007).

We used SIMILE to compare the eight participant-generated melodies against all 18 computer-generated melodies from the Generation phase (six in each elaboration condition). From this we counted the number of melodies plagiarised in each condition by assigning a score of 1 to all *opti3* values greater than 0.4, and 0 to *opti3* values below 0.4.

**Recognition task.** Ratings of Familiarity and Source were analysed separately. A 3 (Intervention: Day 1, Day 2, Control) × 6 (Elaboration Condition: Participant, Improvement-Modification, Improvement-Extension, Imagery, Control, New) design was used for analyses of Familiarity and Source respectively.

## Results

Due to the exploratory nature of this research, and the low sample size, we used Bayesian procedures in the following analyses. The Bayes Factor $BF_{10}$ calculates the relative likelihood of the experimental hypothesis $H_1$ being true versus the null $H_0$, given the obtained data. (Likewise, $BF_{01}$ represents the likelihood of the null being true, rather than the experimental hypothesis). As the Bayes Factor is calculated from the ratio of the posterior and prior odds of the hypothesis being true, a *BF* greater than 1 indicates greater likelihood of the experimental hypothesis being true than the null (Dienes, 2011). According to Jeffreys' (1961) criteria, a $BF_{10}$ of 3 or above indicates substantial evidence in favour of the hypothesis, and $BF_{10}$ of 10 or above represents strong evidence in favour of the hypothesis.

### Generate-New phase

We excluded three participants (2 male, 1 female) from each test due to issues with corrupted storage in the program databases. One participant was excluded as the intervention played for only one minute. One participant had to reschedule the second session, and so experienced an eight-day retention interval. The final sample comprised 40 participants (17 male, 23 female), Control $n$ = 13, Session 1 $n$ = 12, Session 2 $n$ = 15.

Table 5.1.

*Mean (SD) Number of Melodies Plagiarized in Each Condition in the Generate-New phase.*

| | Intervention group | | | |
|---|---|---|---|---|
| | Control | Session 1 | Session 2 | Overall |
| Improvement-Modification | 1.3 (1.0) | 0.6 (0.8) | 1.4 (1.2) | 1.1 (1.1) |
| Improvement-Extension | 1.3 (1.3) | 1.1 (0.8) | 1.6 (0.7) | 1.4 (1.0) |
| Imagery | 1.3 (1.3) | 1.6 (1.5) | 1.4 (0.8) | 1.4 (1.2) |
| Control | 1.6 (1.4) | 2.1 (1.0) | 1.5 (2.0) | 1.7 (1.5) |

In the Generate-new task, as for previous studies across domains, overall rates of plagiarism were high. Descriptive statistics for each elaboration condition, as well as rates of plagiarism overall are provided in Table 5.1. Across conditions, plagiarism ranged from 0.6 melodies (Improvement-modification condition, Session 1 participants) to 2.1 melodies (Control condition, Session 1 participants). Given that there are six computer-generated melodies in each condition, this represents a rate of 10-35%. Rates of plagiarism overall were similar in the three elaboration conditions, with the highest number of melodies plagiarised in the control condition. On examining means within the three intervention groups, mean rates of plagiarism were also similar across all conditions for participants in the Control and Session 2 groups. However, the number of melodies containing intrusions was lower in the elaboration conditions for participants receiving the intervention at the end of Session 1. Given that the overall findings showed little difference between conditions, we used the

Bayes Factor $BF_{01}$ in the following analyses to determine whether the data showed greater support for the null than the alternate hypothesis.

To test whether the intervention affected plagiarism, and whether plagiarism varied as a factor of elaboration, we conducted a 3 (Intervention: Session 1, Session 2, Control) × 4 (Elaboration Condition: Improvement-Modification, Improvement-Extension, Imagery, Control) Bayesian repeated-measures ANOVA, with the dependent variable being the number of melodies plagiarised. This analysis showed substantial support for the null hypothesis in both main effects and the interaction. Plagiarism did not vary due to the intervention, $BF_{01}$ = 8.96, or elaboration condition, $BF_{01}$ = 3.07. Likewise, support was not obtained for a model including both main effects, $BF_{01}$ = 25.43, or a model including both main effects, plus an interaction between the intervention and elaboration condition, $BF_{01}$ = 143.75.

This result was surprising, as it contrasted with our previous studies in music, where all forms of elaboration increased generate-new plagiarism (Rainsford et al., under review). In this study, while generate-new plagiarism was present in all conditions, we found no evidence to suggest that the intervention was effective in reducing plagiarism.

**Recognition task**

We excluded three participants (2 male, 1 female) from each test due to issues with corrupted storage in the program databases. One participant was excluded as the intervention played for only one minute. One participant had to reschedule the second session, and so experienced an eight-day retention interval. The final sample comprised 40 participants (17 male, 23 female), Control $n$ = 14, Session 1 $n$ = 12, Session 2 $n$ = 14.

**Familiarity.** Results for the Recognition test showed greater consistency with previous studies in music. Descriptive statistics for participant familiarity ratings in each group are provided in Table 5.2. Here we observed a pattern of results that were more consistent with our previous studies, as participants in all groups showed greatest familiarity for their own melodies, and least for the novel melodies. Both the elaborated and control melodies from the generation phase were rated as more familiar than novel melodies, but less familiar than the participant's own melodies. Familiarity was elevated for the elaborated melodies, which had received increased exposure, in comparison to control melodies. As these patterns suggested that there might be differences in elaboration conditions, we used the Bayes Factor $BF_{10}$ to test whether greater support existed for the alternate than the null hypothesis.

Table 5.2.

*Mean (SD) Familiarity Ratings for Melodies in Each Elaboration Condition, By Intervention Group.*

| | Intervention group | | | |
|---|---|---|---|---|
| | Control | Session 1 | Session 2 | Overall |
| Participant | 1.9 (0.9) | 2.3 (0.7) | 1.4 (1.3) | 1.8 (1.0) |
| Improvement-Modification | 1.0 (1.3) | 1.2 (1.1) | 0.7 (1.3) | 1.0 (1.2) |
| Improvement-Extension | 1.0 (0.7) | 1.7 (1.0) | 1.1 (1.5) | 1.3 (1.1) |
| Imagery | 0.9 (0.9) | 1.5 (1.0) | 0.9 (1.5) | 1.1 (1.2) |
| Control | 0.0 (1.2) | 0.8 (1.3) | 0.2 (1.3) | 0.3 (1.3) |
| New | -1.2 (1.0) | -0.1(1.5) | -0.3 (1.3) | -0.6 (1.3) |

We conducted a 3 (Intervention: Session 1, Session 2, Control) × 6 (Condition: Participant, Improvement-Modification, Improvement-Extension, Imagery, Control, New) Bayesian repeated-measures ANOVA on participant ratings of Familiarity. The analysis showed strong support for an effect of condition on familiarity, $BF_{10} = 4.27e^{26}$. However, we did not find evidence that familiarity levels varied due to the intervention, $BF_{10} = 0.48$. Strong support was also obtained for a model including both main effects of intervention and elaboration condition, $BF_{10} = 2.78e^{26}$, and a model including both main effects and their interaction, $BF_{10} = 4.47e^{25}$. Although both of these models were better supported than the null, when we compared them with the model including only the main effect of condition, the model with a main effect of condition was best supported (all $BF_{10} < 1$; Mathôt, 2017).

We then conducted Bayesian paired-samples t-tests to examine the effects of the different conditions on familiarity with melodies across all groups. As observed in the descriptive statistics, participant's own melodies were rated as more familiar than all other conditions (all $BF_{10} > 64$), and new melodies were less familiar than other conditions (all $BF_{10} > 406$). Comparing the three elaboration conditions (Improvement-Modification, Improvement-Extension, Imagery) with the control condition, exposure through elaboration increased familiarity in all conditions (all $BF_{10} > 29$). However, within the three elaboration conditions, no differences in familiarity were observed (all $BF_{10} < 1$; see Figure 5.1). Consistent with our previous experiment in music, elaboration increased familiarity with melodies in comparison to control, but the effect of elaboration did not differ between conditions.

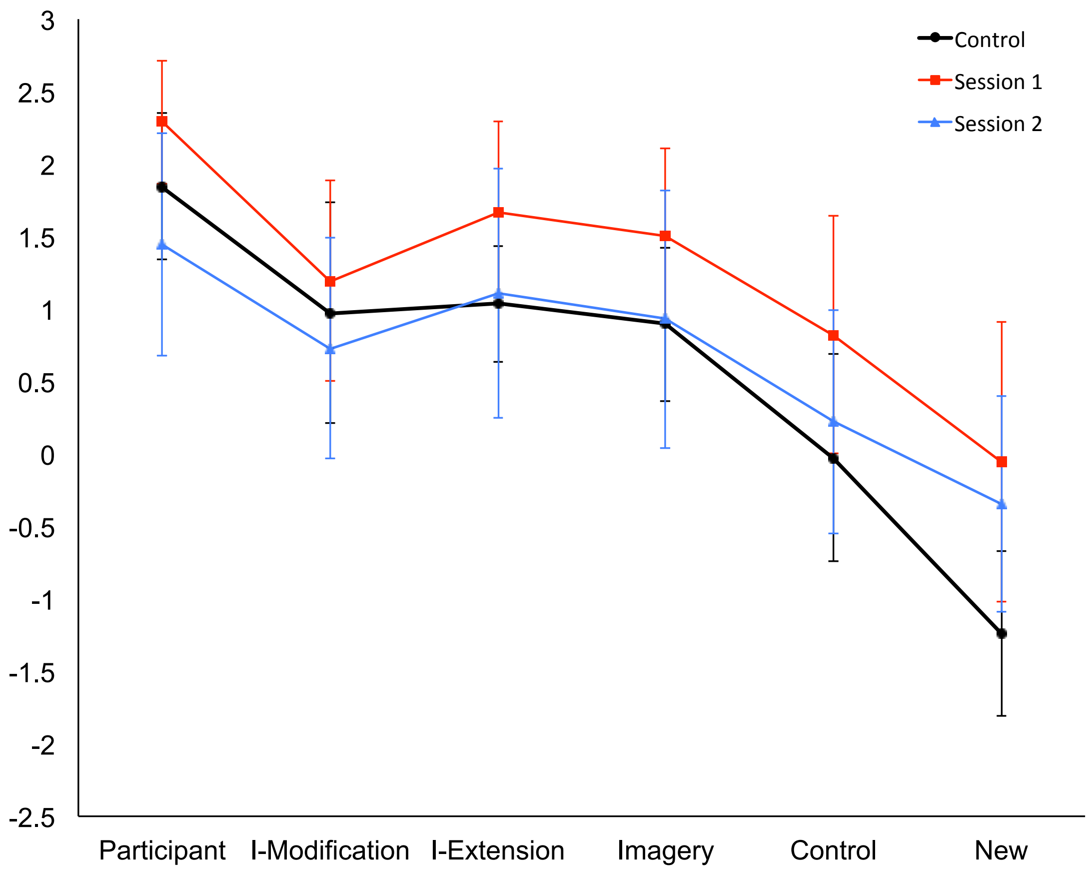


*Figure 5.1.* Mean ratings of familiarity for melodies across conditions. Elaboration increased familiarity with melodies in comparison to control, but no differences were observed between experimental groups. (Error bars indicate 95% confidence intervals).

**Source recognition.** Participant source ratings followed a similar pattern to familiarity ratings. Across conditions, participants gave the highest ratings to their own melodies, indicating that these were recognised well. Novel melodies received the lowest ratings, showing that these were best identified as computer-generated. Ratings for the computer-generated melodies from the generation phase (including those which had been elaborated, as well as control melodies) were somewhat higher than novel melodies, indicating that plagiarism occurred in these conditions. Inspection of individual source ratings revealed that all participants claimed at least one computer-generated melody was their own. Descriptive statistics for the three intervention groups are provided in Table 5.3. As for the familiarity ratings, these patterns suggested that there might be differences between elaboration conditions, and so we used the Bayes Factor $BF_{10}$ in the following analyses to test whether greater support existed for the alternate than the null hypothesis.

Table 5.3.

*Mean (SD) Source Ratings for Melodies in Each Elaboration Condition, By Intervention Group.*

| | Intervention group | | | |
|---|---|---|---|---|
| | Control | Session 1 | Session 2 | Overall |
| Participant | 0.9 (1.4) | 1.1 (1.2) | 0.8 (1.1) | 0.9 (1.2) |
| Improvement-Modification | -0.6 (1.5) | -0.3 (1.3) | -0.6 (1.3) | -0.5 (1.3) |
| Improvement-Extension | -0.5 (1.3) | -0.2 (1.2) | -0.4 (1.1) | -0.4 (1.1) |
| Imagery | -0.8 (1.0) | -0.4 (1.2) | -0.4 (1.2) | -0.6 (1.1) |
| Control | -1.1 (1.0) | -0.5 (1.5) | -0.9 (1.2) | -0.9 (1.2) |
| New | -2.1 (0.8) | -1.4 (1.3) | -1.5 (1.4) | -1.6 (1.2) |

To test whether the intervention affected participant source ratings, we conducted a 3 (Intervention: Session 1, Session 2, Control) × 6 (Condition: Participant, Improvement-Modification, Improvement-Extension, Imagery, Control, New) Bayesian repeated-measures ANOVA on participant Source ratings. The analysis showed strong support for a main effect of condition on source recognition, $BF_{10} = 1.41e^{23}$. As for the familiarity ratings, no evidence was found to support a main effect of intervention, $BF_{10} = 0.23$. Again, similar to the familiarity ratings, strong support was also obtained for a model including the two main effects of condition and intervention, $BF_{10} = 4.55e^{22}$, and a model including these effects plus their interaction, $BF_{10} = 1.02e^{21}$, however, comparison of these models against the condition only model revealed that the model including only a main effect of condition was best supported (all $BF_{10} < 1$; see Figure 5.2).

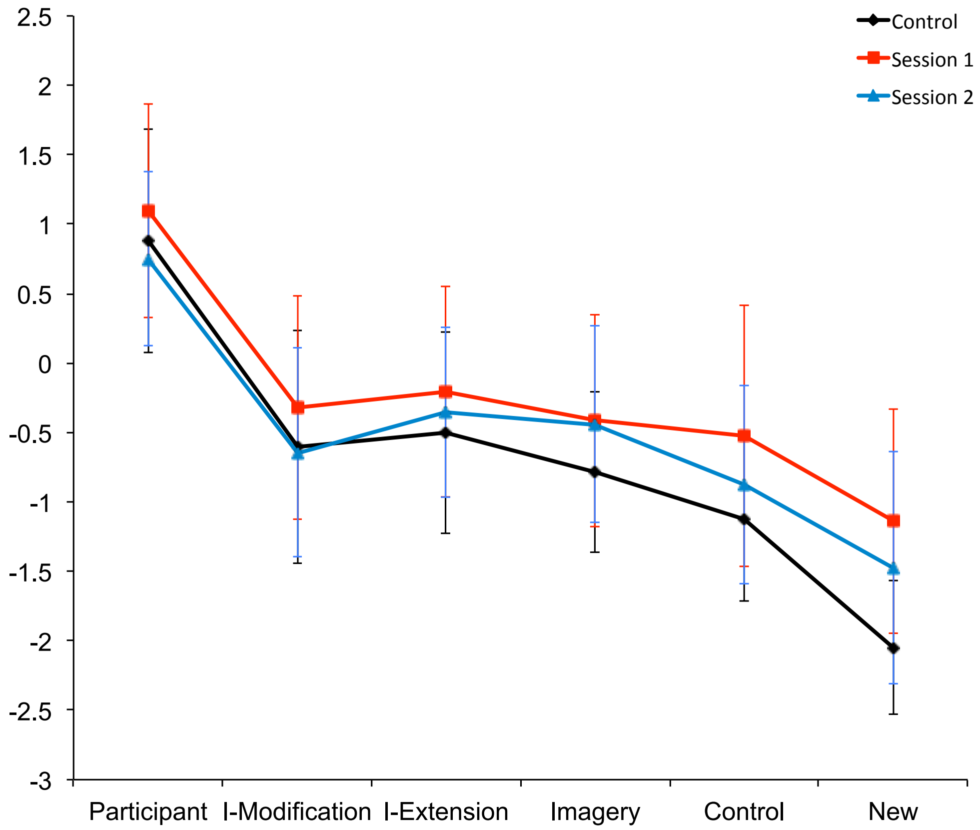


*Figure 5.2.* Mean participant source ratings across conditions. Elaboration increased plagiarism only in the Improvement-Extension condition, but no effect of the intervention was detected on source memory for melodies. (Error bars indicate 95% confidence intervals).

To examine this result further, we used Bayesian t-tests to investigate the effect of condition on participant source ratings. As for the familiarity ratings, participants recognised their own melodies well, as these were rated substantially higher than melodies in all other conditions (all $BF_{10}$ > 125,866). Likewise, new melodies were rated substantially lower than all other melodies (all $BF_{10}$ > 69), indicating that these were better identified as computer-generated.

Examining the effect of the three elaboration conditions in comparison to control, following improvement-extension, melodies were rated substantially higher, indicating that these were more likely to be considered as the participants own, $BF_{10}$ = 5.28. Following improvement-modification ($BF_{10}$ = 0.68) and imagery ($BF_{10}$ = 0.81) melodies received higher mean ratings than control melodies, but no evidence was obtained to support a difference between these conditions and the control melodies. No differences were found between the three elaboration conditions (all $BF_{10}$ < 1).

In summary, as for the Generate-new task, plagiarism occurred in all conditions, but the pattern of results was atypical in comparison to previous studies in music (Rainsford et al., under review). In our previous studies, we found that all forms of elaboration increased plagiarism in comparison to control. We also found a parallel increase in familiarity for melodies as well as participant source ratings after all forms of elaboration in comparison to control, which suggested that plagiarism in music increases after re-exposure to others' ideas, regardless of the task involved. In this study, we observed some differences to these findings. Although familiarity ratings were greater in all three elaboration conditions than control, only improvement of others' melodies increased the likelihood that they were claimed as the participants own. While these results were therefore atypical to previous studies, we did not find any evidence to suggest that this change in source ratings was due to the intervention task.

**Discussion**

In this pilot study, we tested whether an intervention, in the form of a musical distractor task (Glanzer & Cunitz, 1966; Petrusic & Jamieson, 1978), would reduce memory strength for others' melodies, and thus, reduce unconscious plagiarism.

Overall, as for previous studies of unconscious plagiarism, high rates of plagiarism were observed in both the generate-new task and the recognition task. Across conditions, generate-new plagiarism ranged from 10-35% of ideas presented, similar to rates observed across domains. Brown and Murphy (1989) found that generate-new plagiarism ranged from 8.6-14% of ideas; in this study ideas were simply generated, and not elaborated before testing. Stark and colleagues observed that although idea elaboration reduced plagiarism, on average, 18.8-20% of all ideas contributed in the generate-new task were plagiarized (Stark & Perfect, 2006; Stark et al., 2005).

Plagiarism in the recognition task was also extremely prevalent in this study. All participants claimed at least one of the computer-generated melodies was their own, with some degree of confidence (i.e. with a score of 1 ("somewhat agree") or greater). This finding was consistent with our previous studies in music, where we observed source monitoring errors at a rate of 94-100% in the recognition test (Rainsford et al., under review). The level of recognition error which we observe in music is consistently higher than rates observed in verbal tasks, where Stark and Perfect (2007) found an 80% rate of source monitoring error, although plagiarism was measured categorically rather than through confidence ratings in their study.

However, when we examined the effects of elaboration on plagiarism, the pattern of results was atypical in both tasks in comparison to our previous experiments. In the generate-new task, in contrast to previous studies, elaboration did not increase plagiarism relative to control melodies (Rainsford et al., under review). However, no evidence was obtained to suggest that this was due to the intervention, or an interaction between the intervention and the elaboration conditions.

In the source recognition task, only idea improvement increased plagiarism relative to control, whereas in our previous studies in music, all forms of elaboration increased plagiarism (Rainsford et al., under review). However, again we found no evidence that the intervention was effective in reducing plagiarism, or that these differences were due to an interaction between the intervention and specific elaboration conditions. This was surprising, as a memory-strength based account of musical plagiarism would suggest that a distractor task should reduce strength in memory for musical ideas, and thus reduce plagiarism.

The pattern of familiarity ratings which we observed in this experiment offered some explanation as to why we did not detect an effect of the intervention on plagiarism. In previous studies, we observed a parallel increase in familiarity ratings in the elaboration conditions, together with an increase in both generate-new plagiarism and source monitoring errors in these conditions. This increase in familiarity shows that plagiarism in music occurs due to re-exposure to ideas, regardless of the task involved (Rainsford et al., under review). In this study, we did not detect such a correspondence between familiarity ratings and plagiarism in either the generate-new task or participant source ratings. Further, participant familiarity ratings followed a pattern consistent with previous studies, with an increase in familiarity shown after all forms of elaboration in comparison to control melodies.

One reason therefore that the intervention may not have been effective is that it may not have sufficiently reduced strength in memory for the computer-generated melodies. If participant familiarity ratings showed a similar pattern to previous studies, and no differences were observed in familiarity ratings due to the intervention, then memory strength was not reduced by the intervention. It is possible that a two-minute intervention presented during the retention interval was too brief to show an effect, given that participants had by that time worked on melody generation and elaboration for an hour. We asked participants to listen to the intervention for two minutes, because they were receiving the intervention without explanation from the experimenter, and atonal music is often perceived as unpleasant (Daynes, 2010).

An alternative possibility is that randomly-generated notes do not interfere with others' music to the same degree that a melody would interfere. We used atonal, randomly-generated music to avoid the possibility of the interference task influencing original composition. However, studies of music comprehension suggest that melodic stimuli are more distracting than atonal stimuli, because attention is drawn to predictable tonal structures (Pearsall, 1989). Given that plagiarism in music occurs after repeated exposure (Rainsford et al., under review), copyrighted music could not be used in an interference task due to the possibility that this would induce plagiarism from the interference task. However, libraries of copyright-free and Creative Commons-licensed music are readily available on the internet. Testing the effectiveness of a melodic interference task in comparison to random notes would increase understanding of the cognitive mechanisms involved in unconscious plagiarism. If used as a means for composers to avoid plagiarism, consideration would then have to be given to the degree to which copyright-free music would unduly influence the creative process.

It is also possible that administering the intervention during the retention interval of the paradigm was too late. At this stage of the paradigm, considerable consolidation of memory of the computer-generated melodies would have already occurred following idea generation and elaboration (Stark et al., 2005); this was indeed reflected in the increase in participant familiarity ratings across the elaboration conditions.

However, the atypical pattern of results found here, in particular in the generate-new data and source ratings for the control group, are difficult to explain. One possibility is that the small sample size in this pilot study was not sufficient to show an effect. Three-stage paradigm studies produce noisy data (Hollins & Lange, 2016), thus, a larger number of participants per cell may be required to detect an effect.

Another possibility which has not been considered to date in studies of unconscious plagiarism is the effect of individual differences in creative tastes on plagiarism. Generate-new plagiarism in verbal creative tasks has been shown to be influenced by positive valence of ideas. In Perfect and colleagues' (2009) and Bink and colleagues' (1999) research, ideas suggested by experts were more likely to be plagiarized; in Perfect and colleagues' study (2008b), ideas that were independently rated by judges as higher in quality were more likely to be plagiarized. In music, we also found evidence that liking increases plagiarism, as we found that generate-new plagiarism increased after re-exposure (Rainsford et al., under review). This was most likely due to the *mere exposure effect* (Zajonc, 1968), as repeated exposure would increase liking for melodies (Peretz et al., 1998). It is possible that the atypical pattern of results found in the generate-new task of this experiment are also influenced by individual differences in liking for melodies. Future research in plagiarism across domains is therefore recommended to examine the effects of liking on plagiarism of ideas.

We observed one consistency in this study with previous three-stage paradigm research across domains, in the high rates of plagiarism found in both tasks. Although no clear pattern explained generate-new plagiarism, rates of plagiarism in this task ranged from 10% to 35% of ideas in each condition, comparable to our previous research (Rainsford et al., under review), as well as studies by Brown and Murphy (1989) and Stark and colleagues (2006; Stark et al., 2005). Our studies also show that musicians are highly prone to source recognition errors. All participants in this study claimed that at least one of the computer-generated melodies was their own; in our previous studies plagiarism in the recognition task ranged from 94% (Experiment 1) to 100% (Experiment 2; Rainsford et al., under review).

In the verbal domain, a number of different strategies to reduce plagiarism have been tested. Source monitoring has been improved by increasing the presence of source cues (Hollins et al., 2016; Macrae et al., 1999), holding the participant accountable for plagiarism (Weidler et al., 2012), providing participants with financial incentives to avoid plagiarism (Stark et al., 2005), and by increasing item-specific processing through negative mood induction (Gingerich & Dodson, 2013). While these approaches were successful in reducing the risk of verbal plagiarism, no laboratory study has yet succeeded in completely removing incidences of unconscious plagiarism. Court cases involving plagiarism can seriously affect the professional and personal lives of the musicians involved (Pena, 2014). There is a pressing need for further research to develop an effective intervention strategy which can reduce the risk of unconscious plagiarism in music.

# Chapter 6

## Discussion

The aim of this research was to investigate the cognitive mechanisms specific to unconscious plagiarism of musical stimuli. In verbal creative tasks, unconscious plagiarism has been shown to be increased after improving others' ideas (Stark & Perfect, 2008; Stark et al., 2005). This was explained theoretically in accordance with the source monitoring framework (Johnson et al., 1993) as a form of internal-external source confusion. The internal cognitive processes associated with idea improvement are similar to idea generation, leading to confusion of others' ideas as internally generated (Stark et al., 2005). Perfect and Stark (2008a) proposed that this might explain unconscious plagiarism cases in music, as a composer frequently elaborates on ideas during the process of completing a song. In these studies, we aimed to test this proposal by investigating the role of elaboration in music plagiarism.

The key findings of this research are summarized below in two sections; first, the development of a method for testing memory for melodic stimuli, and second, the findings of studies testing unconscious plagiarism in music. From these findings, a proposal is given for a model of unconscious plagiarism across domains, and suggestions are made for further research to test the factors associated with unconscious plagiarism specified in this model. As these studies revealed that musicians are more vulnerable to unconscious plagiarism than previously understood, the legal and professional implications of this finding are discussed.

**Development of a method for testing memory for melody**

In order to test unconscious plagiarism using musical stimuli, it was first necessary to develop a method for administering the Brown and Murphy (1989) three-stage paradigm with a musical generative task, in a format accessible to both expert and non-expert musicians. The first two studies of this thesis were therefore designed to test a proposed method for administering studies of musical recall and recognition in the general population as well as in trained musicians. In Study 1, we presented The MUSOS Toolkit (Rainsford et al., 2016), a computer-based method for testing memory for musical stimuli. In designing this software, we further aimed to address the low rate of replication studies in music cognition (Frieler et al., 2013), a concern also reflected in recent calls for increased replication across the broader field of psychology (Open Science Collaboration, 2015).

In Study 1, we addressed two key methodological challenges that potentially hinder rates of replication; the difficulty of measuring recall responses in music, and access to a novel stimulus set unhindered by copyright or licensing issues. Fewer studies of musical recall have been undertaken in comparison to music recognition, due to the difficulty of measuring sung or performed responses from participants (Müllensiefen & Wiggins, 2011). Study 1 presented a method which allows the participant to input and audition musical recall responses electronically. The program is designed using common frameworks which make it accessible for non-musicians to use (Aikin, 2014; John & Bass, 2001), so that studies are no longer limited to both participants and researchers with specialist musical training. The method was tested in a sample of 26 first-year psychology students who were able to use the program in a self-directed manner. The stimulus set developed to accompany the program presents 156 novel musical stimuli which are released under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International license (Creative Commons, 2013) so that a researcher may freely access the stimuli, and reproduce examples in a journal article without copyright issues.

In developing a stimulus set for use in studies of music and memory, it is important that the researcher has access to information describing properties of the stimuli that are relevant to successful storage and retrieval of items. In music, these features include pitch (Deutsch, 1969, 1975), interval relationships (Deutsch, 1972), tonality (Krumhansl, 1991; Krumhansl & Kessler, 1982; Schmuckler, 1997) and contour (Dowling, 1978; Dowling & Fujitani, 1971). While rhythm is also important to memory for music (Halpern, 1984), in these stimuli we held rhythm constant so that we could focus on understanding memory for melody (Halpern & Bower, 1982). We measured these features of the stimulus set using the software FANTASTIC (Müllensiefen, 2009a). In addition, a sample of 36 participants rated the software for their distinctiveness and valence, two variables associated with improved memory for musical items (Bailes, 2010; Huron, 2006; Schmuckler, 1997).

Computational analysis showed that specific musical features were associated with perceived distinctiveness and valence. Increases in distinctiveness correlated with increased variability in pitch and intervallic content, consistent with previous findings by Bailes (2010). Ambiguity in tonality, and greater variation in contour was also associated with increased distinctiveness, suggesting further consistency with Bailes (2010) as well as Vuvan and colleagues' (2014) proposal that atonal and highly unexpected musical notes are perceived as distinctive.

Positive valence of melodies was associated with a more restricted intervallic range, but also a wider modal (most frequent) interval. Melodies which correlated more closely with Western diatonic scales were perceived as higher in valence, consistent with research by Krumhansl (1990, 1991), Huron (2006), and Johnson-Laird and colleagues (2012).

Pilot testing was then conducted to establish a subset of 80 melodies (40 eight-note, 40 sixteen-note), half of which were designed to be very difficult, and half very easy to remember. Data from a recognition test using these stimuli verified these classifications. In addition, Bayesian *t*-tests comparing the musical properties of these melodies showed evidence that the two groups of melodies differed in distinctiveness, valence, pitch and intervallic content, contour, and tonality. The software and accompanying stimuli therefore provide a method for administration and accurate recording of participant responses from both trained musicians and non-musicians.

**The distinctiveness effect in memory for music**

Having developed a computer-based method for administering music cognition studies, and a stimulus set measured for factors important to memory for music, in Study 2, we demonstrated the use of the MUSOS Toolkit (Rainsford et al., 2016) by testing whether the distinctiveness effect generalizes to musical stimuli.

Distinctiveness is associated across many domains with improved recognition of items (Brandt et al., 2006; Dodson & Schacter, 2001; Israel & Schacter, 1997; Schacter & Wiseman, 2006; Valentine, 1991). In music, distinctiveness has been identified as a factor in the point of recognition of a melody (Bailes, 2010), and the recognition of individual tones (Vuvan et al., 2014), but no studies have previously tested the distinctiveness effect in the recognition of whole melodies.

Using a subset of 96 melodies from the stimulus set developed in Study 1 which had received the highest and lowest participant ratings of distinctiveness, we first established, using FANTASTIC (Müllensiefen, 2009a), a set of musical features associated with perceived distinctiveness. Variance in distinctiveness was associated with increased range and variability in pitch and intervallic content, wider intervals, increased variation in contour, and greater ambiguity in tonality. These findings were consistent with the literature examining the role of distinctiveness in memory for melody, in particular Bailes' (2010) modelling of the role of distinctive pitch and intervallic content in melodic recognition, Vuvan and colleagues' (2014) finding that atonal and incongruous notes are better remembered, and Müllensiefen and Halpern (2014)'s research showing that highly varied contour and unusual melodic motifs within a melody predict improved recognition. Using Bayesian *t*-tests, we further verified that the high- and low-distinctiveness stimulus sets differed according to the properties identified in computational analysis.

We then conducted an old-new recognition test using the melodies. Results showed a significant advantage for distinctive stimuli, which was due to more hits (correct recognition of previously studied items) for distinctive melodies, rather than a reduction in false alarms. This extends the findings of Bailes (2010) who showed that distinctive material results in an earlier point-of-recognition of a melody, and Müllensiefen and Halpern (2014) who used computer-based modelling following a recognition test to identify that items that were better recognized contained distinctive features.

While our study did not demonstrate the mirror effect (Glanzer & Adams, 1985), where distinctive items are associated with both an increase in hits as well as a decrease in false alarms, this does not preclude an advantage for distinctive items in recognition (Pazzaglia et al., 2014). As our result is consistent with Müllensiefen and Halpern (2014), who demonstrated that correct recognition in music is associated with different melodic features to reduced false identification of lures, further research may establish that the distinctiveness effect functions differently in music. We further found an interaction such that the effect of distinctiveness was greater for longer melodies. This may be due to the temporal nature of music, where the distinctiveness effect may accumulate over time (Bailes, 2010).

**Key mechanisms associated with unconscious plagiarism in musical tasks**

The remaining two studies of the thesis used the methodology developed across the first two studies to investigate the cognitive mechanisms associated with unconscious plagiarism in music. These represent the first tests of unconscious plagiarism using musical stimuli. Study 3 incorporates the original Honours research project investigating unconscious plagiarism (Rainsford, 2013) together with a large-scale replication conducted during the candidature in a sample of 65 participants. In Study 4, we conducted a pilot test investigating a method for reducing plagiarism of the computer-generated melodies.

Both of these studies demonstrated considerable theoretical differences between the mechanisms which underpin plagiarism in verbal and musical domains. Overall, whereas verbal plagiarism is associated with source confusion following idea elaboration (Stark & Perfect, 2006, 2008; Stark et al., 2005), musical plagiarism was found to increase via exposure. Below, we summarize these findings and the cognitive mechanisms associated with unconscious plagiarism in music which we identified from these studies, and contrast these with the mechanisms identified as influencing verbal plagiarism. From these observations, we propose a model of the factors which influence unconscious plagiarism across domains, with directions for further testing to verify this model.

**Exposure-based effects in music.** In the verbal domain, the studies of Hollins and colleagues have shown two key effects, neither of which were replicated in music: a) that recall-own plagiarism and source-monitoring errors during recognition are associated with improvement of others ideas, but not imagery (Perfect & Stark, 2008a, 2008b, 2012; Stark & Perfect, 2007; Stark et al., 2005), b) a double-dissociation between factors increasing recall-own and generate-new plagiarism. Generate-new plagiarism is increased by idea quality or valence, but reduced by elaboration (both improvement and imagery). This is because idea elaboration functions to improve the strength of an idea in memory, thus it is more easily rejected as previously encountered when attempting to generate new solutions (Bink et al., 1999; Perfect et al., 2009; Perfect & Stark, 2008b; Stark et al., 2005).

In Study 3, we did not observe a singular effect of improvement on plagiarism found in verbal tasks. Instead, musical plagiarism increased following re-exposure to others' ideas, regardless of the elaboration task involved. Our familiarity data further supported an exposure effect in music, as participants demonstrated increased familiarity with those items which they were more likely to plagiarize. Participants own and novel melodies were discriminated well, but following all elaboration tasks, melodies that had been elaborated were both rated as more familiar, and plagiarized more often than control melodies. Critically, for an exposure effect, no differences were observed between elaboration conditions in both familiarity and plagiarism.

A further novel finding was that exposure increased both generate-new and recognition plagiarism. We did not observe the dissociation seen in verbal tasks between the factors affecting plagiarism in recall and recognition, and generation of new ideas (Perfect & Stark, 2008a; Stark & Perfect, 2007). In music, exposure appears to increase plagiarism when recognizing ideas, as well as when composing new music.

This result was therefore more consistent with Marsh and Bower (1993)'s strength-based model of unconscious plagiarism, where own ideas are associated with the greatest strength in memory. As memory strength for others' items increases, they are more likely to be confused as one's own (Marsh & Bower, 1993; Marsh & Landau, 1995). This proposal was not supported in verbal studies, where no difference in memory strength (shown through correct recall) was observed between ideas that had been subject to imagery or improvement. In music, however, re-exposure to others' ideas appears to increase strength in memory sufficiently for these to cross the threshold at which they are considered to be one's own ($T_{COMPUTER}$, Figure 1.1).

While this model effectively explains our recall-own and recognition data, in contrast to studies in verbal tasks, it seems contradictory to suggest a memory-strength explanation for generate-new plagiarism. In the generate-new task, when attempting to create novel solutions a participant does not need to monitor the source of ideas, but merely to reject earlier-encountered ideas as old (Marsh & Bower, 1993; Stark et al., 2005). In music, memory strength should still, as for verbal tasks, improve correct rejection of earlier-presented ideas during the generate-new task, and thus reduce plagiarism (Stark et al., 2005). However, our generate-new data showed the same pattern as the recognition task, suggesting that memory strength was somewhat paradoxically associated with plagiarism in music.

This contradiction may be explained through the *mere exposure effect* (Zajonc, 1968), where exposure to an idea increases both liking and familiarity. In music, the mere exposure effect is particularly powerful and may be observed after a single re-exposure (Peretz et al., 1998; Stalinski & Schellenberg, 2013). Thus, exposure to a computer-generated melody would be expected to increase not only familiarity for that melody, but also liking for it. Crucially, increased liking of melodies should be associated with increased likelihood of unconscious plagiarism, if item valence increases plagiarism across domains. Our generate-new findings from Study 3 are therefore consistent with those from verbal tasks, where item valence increases plagiarism (Bink et al., 1999; Perfect et al., 2009; Perfect & Stark, 2008b).

**The role of expertise in unconscious plagiarism.** In Study 3, we found no evidence to support an effect of domain-relevant expertise on plagiarism of music, either when recognizing ideas, or when generating new melodies. This was surprising, as expert memory is normally associated with improved recognition of domain-relevant items (Bailes, 2010; Chase & Simon, 1973; Hunt & Rawson, 2011; Rawson & van Overschelde, 2008). Further, Deffenbacher (1980)'s optimality hypothesis states that metacognitive judgments (which include judgments of source) should be more accurate when memory conditions are optimal, because the quality of memories on which judgments are made is higher. Given that expertise leads to optimized storage and retrieval of ideas from semantic networks (Hunt & Rawson, 2011), this suggests that experts should show improved source monitoring in comparison to non-experts. However, expertise may have separate effects on memory and metacognitive performance (Löffler et al., 2016). In Study 3, we found no evidence to support the proposal that expert memory improves source monitoring. Our findings, together with those of Löffler and colleagues (2016), suggest that the relationship between expertise and metacognition may be more complex.

The optimality hypothesis further suggests that increased memory strength in both experts and non-experts should result in more accurate metacognitive judgements (Bothwell et al., 1987; Deffenbacher, 1980). We observed the opposite in Study 3, where elaboration increased judgements of familiarity for melodies in experts and non-experts, but also increased plagiarism in both groups. While a reduced familiarity for melodies overall was observed in the expert sample in Experiment 2 of Study 3, showing consistency with conservative decision-making in experts (Lueddeke & Higham, 2011; Thompson et al., 2013), this conservatism did not influence source judgements in the expert group, or rates of plagiarism, representing errors in source judgements, when experts generated new melodies.

Our findings of an association between memory strength and musical plagiarism are thus inconsistent with the optimality hypothesis, and further support a reduced role of source monitoring processes in music. While our studies represent the first test of expert memory under the three-stage paradigm, Dow (2015) found that expert scientists and engineers were less likely to plagiarize from examples than first-year students in a divergent thinking design task. This task was somewhat similar to the Alternate Uses test (Christensen et al., 1960) used by Stark and colleagues (2005); however, participants were required to redesign existing objects, rather than suggest alternate uses for objects (Dow, 2015). Our findings may therefore represent a further difference in the role of expertise in source memory for music versus other domains.

However, the role of expertise in unconscious plagiarism has only yet been investigated in these two studies. The results of Study 3 do show consistency with the broader literature on false memory, where experts have been found to be equally vulnerable to false memory effects, if not more so, than novices. Patihis and colleagues (2013) found no differences in the effect of a false autobiographical memory paradigm in individuals with highly superior autobiographical memory in comparison with normal controls, when arguably these individuals' domain of expertise is their own autobiographical past. Domain-relevant expertise also increases false memory in DRM paradigm studies (Castel et al., 2007; Patihis et al., 2013). While expertise did not increase false memory in our studies of unconscious plagiarism, our findings certainly support an overall conclusion similar to that reached by Patihis and colleagues (2013), that domain-relevant expertise does not provide immunity to memory errors. Both expert and non-expert musicians were highly vulnerable to both source monitoring errors during the recognition task, and unconscious plagiarism when generating new melodies.

**Reducing the risk of unconscious plagiarism in music.** The results of Study 3 suggested that musicians are at much greater risk of plagiarizing than previously thought. An author may be advised to avoid idea improvement, or to take careful notes during extended group project work (Landau & Marsh, 1997; Stark & Perfect, 2008). A musician cannot simply avoid exposure to others' music, as this is an integral part of musical practice (Rosenthal, Wilson, Evans, & Greenwalt, 1988). We therefore decided that the most important follow-up study from an ethical perspective was to test an intervention designed to reduce musical plagiarism.

In verbal word-list studies, verbal and musical distractor tasks have been shown to reduce memory for recently studied items (Glanzer & Cunitz, 1966; Petrusic & Jamieson, 1978). In Study 4, we conducted a pilot study to investigate whether a distractor task, in the form of two minutes of randomly generated musical notes presented during the retention interval of three-stage paradigm, would reduce memory for, and thus, plagiarism of the computer-generated melodies.

In Study 4, as for Study 3, we observed high rates of plagiarism overall. Generate-new plagiarism ranged from 10-35% across elaboration conditions, comparable with findings by Brown and Murphy (1989), who observed generate-new plagiarism of 8.6-14%, and Stark and colleagues, who observed mean generate-new plagiarism of 18.8-20% (Stark & Perfect, 2006; Stark et al., 2005). Source monitoring errors in the recognition task were also very high; as for Experiment 2 of Study 4, all participants claimed that at least one of the computer-generated melodies was their own with some degree of confidence (i.e. with a score of 1, "somewhat agree" or greater), considerably higher than the 80% rate of source monitoring error observed by Stark and Perfect (2007).

We observed atypical patterns of plagiarism following elaboration in Study 4, in comparison to Study 3. In the generate-new task, elaboration did not increase plagiarism. In the recognition task, as for Study 3, participants identified their own and novel melodies well. Source monitoring errors were observed across all conditions, but only improvement increased plagiarism of the computer-generated melodies relative to control, whereas in Study 3, all forms of elaboration increased plagiarism. Yet we did not obtain evidence to suggest that these atypical patterns occurred due to the intervention. This may have been due to the small sample size in this pilot study, as there were less than fifteen participants in each group. Three-stage paradigm studies produce noisy data, and require larger cell sizes to detect an effect (Hollins & Lange, 2016). Further research in a larger sample may reveal an increased effect of the intervention on plagiarism.

However, despite the small sample size, we also obtained evidence to suggest that the intervention did not sufficiently target memory strength. Familiarity ratings followed the same pattern as for Study 3, with participants indicating that their own melodies were the most familiar, and the novel melodies least familiar. Familiarity for the computer-generated melodies which had been elaborated was greater than control melodies, consistent with Study 3. Familiarity ratings function as an index of memory strength, therefore the similarities between these results and those of Study 3 indicate that the distractor task did not sufficiently reduce memory for the computer-generated melodies from the generation phase.

Two possibilities may be considered to inform future studies. First, the distractor task used in this study may not have generated sufficient interference with the computer-generated music. This may have been due to the task being too brief. Listeners often comment that atonal music is unpleasant (Daynes, 2010), therefore we decided to administer only two minutes of musical white noise in this study, because participants were naïve to the purposes of the experiment and thus received the intervention without explanation. A longer distractor task may have a greater effect on memory strength.

Alternatively, an interference task in the form of a melody might generate stronger interference than randomly-generated notes. Melodies are more distracting than atonal stimuli, because attention is drawn to predicting the outcomes of tonal structures (Pearsall, 1989). Further testing is recommended to establish the degree to which melodic stimuli interfere with previously-heard melodies, in comparison to atonal stimuli. Such research would increase understanding of the processing of tonal and atonal music, as well as the cognitive mechanisms involved in unconscious plagiarism. However, if a melodic stimulus was intended as a practical means for composers to avoid plagiarism, consideration must then be given to the degree to which this might influence the creative process. Although a copyright-free melody could be used, in Study 3 we found that some participants plagiarized melodies after a single exposure. Thus, the use of a copyright-free melody to avoid plagiarism could potentially alter the final composition.

The second possibility is that plagiarism is extremely difficult to avoid after ideas have been generated as a group, and then elaborated. Elaboration increases depth of processing of ideas (Craik & Lockhart, 1972), thus consolidating memories for ideas which have been imagined or improved (Stark et al., 2005). Certainly Stark and colleagues (2008) found that, following repeated elaboration, source decisions have an almost 50% likelihood of being wrong. The failure of our intervention method to reduce plagiarism in Study 4 by no means suggests that a memory strength-based approach to reducing plagiarism in music is ineffective, because strength in memory was unaffected, if participant familiarity ratings showed the same patterns in both Studies 3 and 4. Instead, consideration must to be given to the most effective time to administer a memory-strength based intervention within the three-stage paradigm, to avoid consolidation of the computer-generated melodies in long-term memory.

**Towards a model of unconscious plagiarism across domains**

One of the main implications of the present set of studies is that the contrasts between musical and verbal plagiarism provide the foundations for a model explaining unconscious plagiarism across domains (see Figure 6.1). The differences between our findings in music, and previous studies in verbal creative tasks may be explained as a dissociation between implicit and explicit memory processes. Musical knowledge is predominantly acquired implicitly, through exposure (Rohrmeier & Rebuschat, 2012). According to the source-monitoring framework (Johnson et al., 1993), where implicit memory is primarily employed, the processes involved in encoding differentiated contextual information required for source monitoring need not be engaged, because this information is acquired through explicit elaborative processing.

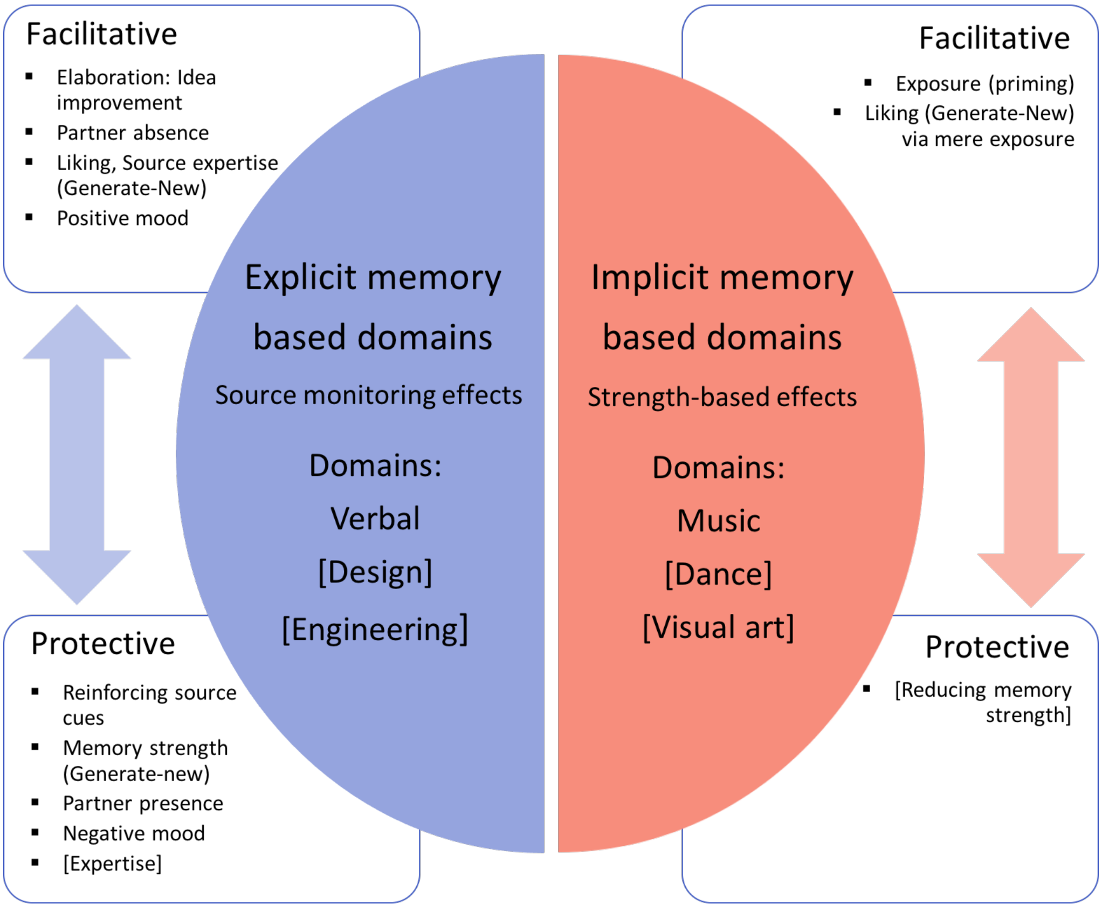


*Figure 6.1.* A model describing factors which influence unconscious plagiarism across domains. Items in square brackets are proposed areas for future research. Explicit memory-based domains incorporate research in verbal creative tasks (Brown & Murphy, 1989; Gingerich & Dodson, 2013; Macrae et al., 1999; Perfect et al., 2009; Stark et al., 2005). Engineering and design are proposed as explicit memory domains due to similarities between Dow (2015)'s design task and the Alternate Uses Task used by Stark and colleagues (2005). The present research in music contributes to the understanding of plagiarism in implicit memory-based domains.

**Facilitative factors: Implicit versus explicit memory processes.** The factors which improve implicit and explicit memory are dissociated; implicit memory improves through exposure (priming), whereas explicit memory is improved through elaboration (Schacter & Church, 1992; Schacter & McGlynn, 1989). It appears from the results of our study that this dissociation extends to factors increasing unconscious plagiarism. Where implicit memory is primarily employed, exposure should increase plagiarism, and a memory strength (i.e. priming) based interpretation is appropriate. If a task relies primarily on explicit memory, improving others' ideas should increase plagiarism, as plagiarism occurs through confusion of contextual source information (Macrae et al., 1999; Stark & Perfect, 2006, 2008; Stark et al., 2005).

This dissociation observed in our research is consistent with the source monitoring framework of Johnson and colleagues (1993). Source monitoring is dependent on contextual cues, which are acquired through explicit, elaborative processing. Priming reflects an undifferentiated facilitation of perceptual processing, where the contextual information used to discriminate source may not be acquired, and thus source monitoring processes may not necessarily be engaged (Johnson et al., 1993). Errors in source discrimination may occur through confusion of source cues, as described in Stark and colleagues research (Stark & Perfect, 2006, 2008; Stark et al., 2005), but may also occur through misattributed fluency, when contextual information has not been stored or accessed (Johnson et al., 1993), consistent with our findings of exposure-based plagiarism in music.

Aside from amnesic patients, explicit memory for events is never entirely absent in priming tasks, and conversely, elaborative processing is not immune from some degree of priming through exposure. While tasks primarily involving implicit memory require less attention to and thus encoding of source-relevant traces (Johnson et al., 1993), this does not mean that musical memories are completely lacking in contextual source information. However, the networks involved in implicit and explicit memory compete for resources (Virag et al., 2015). Thus, it would be expected that, as we observed in Study 3, source monitoring for contextual cues would be extremely limited in a domain where implicit memory is predominantly employed. Conversely, exposure-based effects should be limited in a domain which predominantly recruits explicit memory, as evident in Stark and colleagues' research in verbal tasks (Stark & Perfect, 2006, 2008; Stark et al., 2005).

This proposal of a dissociation in plagiarism between implicit and explicit memory provides clear avenues to make predictions for further testing across domains. For example, in dance, where procedural memory is employed in kinesthetic memory for movement sequences (Stevens, Ginsborg, & Lester, 2010), exposure should also increase plagiarism. Dow (2015) studied plagiarism of examples in divergent thinking design tasks. Participants were asked to design a measuring cup for a visually-impaired person, and a spill-proof coffee cup. Although the samples plagiarised incorporated visual as well as verbal sources, the design task itself would involve explicit processing, similar to designing alternate uses for a brick in Stark and colleagues' experiments (Stark & Perfect, 2006, 2008; Stark et al., 2005). Thus, design and engineering might also be explicit memory-based domains, where plagiarism would be expected to be facilitated by confusion of source cues.

**Protective factors: Source monitoring versus strength-based models.** In addition to the factors which facilitate increased plagiarism, factors protecting against plagiarism must also be considered in a comprehensive model of unconscious plagiarism. Across domains these factors should also be consistent with the above dissociation between implicit and explicit memory in plagiarism. Thus, factors inhibiting plagiarism in tasks where explicit memory is primarily involved should favour a source-monitoring explanation, whereas factors inhibiting plagiarism in implicit memory-based tasks should follow a strength-based model.

In verbal tasks, Macrae and colleagues (1999), and later Hollins and colleagues (2016) have shown that reinstatement of contextual information used to discriminate source shows protective effects against plagiarism. When asked to recall ideas which were initially generated together with a partner, less plagiarism is shown when the partner is present during the recall test than absent. Although the depth of processing involved in idea imagery reinforces memory (Stark et al., 2005), contextual reinstatement may also explain why imagery elaboration does not affect recall-own plagiarism (see Perfect & Stark, 2012; Stark & Perfect, 2006, 2008; Stark et al., 2005). Imagining and rating an idea may also facilitate incidental recall of contextual information such as the person providing the idea, their actions, what they were wearing, and the environment in which testing took place.

In the present experiment, as we simulated the Brown and Murphy (1989) paradigm on a computer, we were unable to test the effects of contextual reinstatement through partner presence on plagiarism. However, if memory strength is the primary factor influencing plagiarism in music, and attention to and encoding of contextual information is poor or even non-existent, then reinstatement of contextual information in a musical study would be expected to have limited effect.

In Study 4, we tested the administration of a distractor task during the retention interval of the three-stage paradigm. We expected that this would reduce memory strength for the computer-generated melodies, and thus plagiarism, as distractor tasks interfere with recall of recently presented information (Glanzer &

Cunitz, 1966; Petrusic & Jamieson, 1978). However, the task which we developed failed to affect memory strength, as participant familiarity ratings were unaffected. While this pilot study was unsuccessful, the pattern of results which we replicated in both experiments of Study 3 would still suggest that inhibition of plagiarism in music is most likely to occur via a reduction in memory strength. Further research is therefore needed to develop an effective method of reducing memory strength for melodies which have been generated and elaborated in the three-stage paradigm.

**Directions for future research based on this model**

The model proposed in Figure 6.1 is based on the research conducted to date into unconscious plagiarism, incorporating all studies conducted in both verbal and musical domains. A number of questions arise from this proposal which provide the basis for future research towards building a comprehensive understanding of unconscious plagiarism across domains.

**Plagiarism in explicit and implicit memory based tasks across domains.** Whereas elaborative processing increases plagiarism in verbal tasks (Stark & Perfect, 2006, 2008; Stark et al., 2005), we found in Study 3 that exposure increased plagiarism in musical tasks. As discussed above, given that musical practice primarily employs implicit memory (Rohrmeier & Rebuschat, 2012), this finding appears to be consistent with a dissociation between factors increasing explicit and implicit memory (Schacter & Church, 1992; Schacter & McGlynn, 1989), and with Johnson and colleagues' (1993) proposal that the contextual cues involved in source discrimination are acquired through explicit elaborative processing, and are not acquired through implicit priming.

To test this proposal, further three-stage paradigm studies are needed across domains. As proposed above, the similarity of Dow (2015)'s design tasks to the

Alternate Uses test (Christensen et al., 1960) suggests that engineering and design might involve explicit memory-based processing, similar to verbal creative tasks. Therefore, to confirm this proposal, the effect of elaboration on plagiarism in these domains needs to be tested.

Aside from music (Rohrmeier & Rebuschat, 2012), implicit memory is also involved in procedural tasks, which in the creative arts may include dance (Stevens et al., 2010) and visual art. Appreciation of visual artworks involves considerable implicit processing (Pelowski, Markey, Forster, Gerger, & Leder, 2017). In a separate experiment, Dow (2015) found increased rates of unconscious plagiarism following exposure to pictorial, in comparison to written examples, but a conclusion regarding the roles of exposure and elaboration in visual art cannot be reached from this study, as these were not tested directly. A method is therefore needed to adapt the three-stage paradigm and manipulations of elaboration to these domains.

**Do the same factors inhibit plagiarism in explicit and implicit memory-based tasks?** Several factors have been identified which increase attention to and monitoring of contextual cues, and thus reduce plagiarism in explicit memory-based tasks. Evidence from verbal studies shows that plagiarism may be reduced through partner presence in the recall-own and generate-new phases (Hollins et al., 2016; Macrae et al., 1999), increased item-specific processing through negative mood induction (Gingerich & Dodson, 2013) and holding the participant accountable for plagiarism (Weidler et al., 2012).

In Study 3, we identified a dissociation between explicit memory-based processing of verbal tasks, and implicit memory-based processing in music. Therefore, in developing Study 4, we expected that a reduction in memory strength, rather than increased availability of contextual cues, would be more likely to reduce musical plagiarism. While the particular task which we trialled failed to reduce memory for the computer-generated melodies (as evident from participant familiarity ratings in Study 4, which were consistent with those from Study 3), it is still likely that the solution to musical plagiarism lies in a memory strength-based approach. To complete this model, further studies are needed to develop an effective strength-based approach to reduce musical plagiarism.

However, testing reinstatement of contextual cues in music, and memory strength reduction in verbal studies would then still be needed to fully establish a dissociation between factors inhibiting plagiarism in verbal and musical domains. As for the factors facilitating plagiarism, testing of inhibitive factors is also needed in other creative domains such as dance, visual art, design and engineering.

**The role of expertise in plagiarism across domains.** To date, Study 3 is the only study using the three-stage paradigm to investigate the role of domain-relevant expert memory in plagiarism. In this study, we found no evidence to support an effect of expert memory on unconscious plagiarism in music. While we were able to replicate this finding in two experiments, it remains unknown whether expertise of the participant (i.e. domain-relevant expert memory, rather than expertise of the source of ideas) affects plagiarism in domains other than music. Dow (2015) found that experts plagiarised less from examples than non-experts when undertaking engineering design tasks. The similarity between Dow (2015)'s design task and the Alternate Uses test (Christensen et al., 1960) used by Stark and colleagues (Stark et al., 2005) suggests that design and engineering might also be explicit memory-based domains. Further testing is therefore needed to establish whether the lack of an effect of expert memory in Study 3 is limited to domains such as music where implicit exposure increases plagiarism.

**Factors which facilitate and inhibit generate-new plagiarism.** As discussed in Chapter One of this research, the factors which facilitate generate-new plagiarism in verbal tasks are dissociated from those which facilitate plagiarism in recall and recognition. Specifically, positive valence of verbal ideas increases generate-new plagiarism (Bink et al., 1999; Perfect et al., 2009; Perfect & Stark, 2008b). In Study 3, we did not observe the dissociation between generate-new and recognition plagiarism found in verbal tasks, as exposure increased plagiarism in both tests. However, we proposed that the effect of exposure on generate-new plagiarism in music was most likely due to the mere exposure effect (Zajonc, 1968). The mere exposure effect in music is known to be particularly strong, and may be evident after a single re-exposure (Peretz et al., 1998). Thus, in music, generate-new plagiarism is also influenced by liking for ideas. Further testing comparing measures of liking for melodies during the generation, elaboration, and generate-new phases would provide the evidence needed to test for this effect directly.

Idea valence might also offer some explanation for the high rates of plagiarism of control melodies which we observed in both studies. Although the percentage of ideas plagiarised in the control condition of both Studies 3 and 4 is not unusual when compared with the findings of Brown and Murphy (1989) and Stark and colleagues (2005), consideration should also be given to the effect of individual differences in liking for ideas on generate-new plagiarism. Previous studies investigating idea valence in generate-new plagiarism have systematically manipulated this variable by randomly assigning quality ratings to ideas from the generation phase (Perfect & Stark, 2008b), attributing a selection of ideas to an expert source (Bink et al., 1999), or assigning participants to generate ideas with a confederate who claimed to be an expert (Perfect et al., 2009). In each of these studies, ideas classified as higher quality were more likely to be plagiarised. However, individual tastes in music, literature or the arts may vary greatly. Further studies are needed to investigate whether participants are more likely to plagiarise ideas which they like when generating new ideas.

**The role of stimulus features in recall-own, recognition, and generate-new plagiarism**

No studies in the literature of unconscious plagiarism have yet examined the effect of stimulus features on either recall-own, recognition, or generate-new plagiarism. The role of stimulus features in music cognition has been the focus of recent research in this domain, for example, identifying musical features which predict improved performance on a melodic recognition test (Müllensiefen & Halpern, 2014), features of melodies which are more likely to be experienced as earworms (Jakubowski, Stewart, Finkel, & Müllensiefen, 2017), and the role of stimulus distinctiveness in dynamic melody recognition (Bailes, 2010). Tools such as FANTASTIC (Müllensiefen, 2009a) have been developed for the purpose of measuring melodic features such as pitch, interval, contour, and implicit tonality.

In Study 1, we developed and tested a stimulus set of 156 original stimuli, with accompanying ratings of perceived distinctiveness and valence provided by a group of 36 participants. In Study 2, we obtained a subset of these melodies with the highest and lowest ratings of distinctiveness, and then used FANTASTIC (Müllensiefen, 2009a) to identify those features which were associated with the perception of melodic distinctiveness.

These melodies could potentially also be used as computer-generated melodic stimuli in a three-stage paradigm study examining whether high- or low-distinctiveness melodies are more likely to be plagiarised. Given that data on the first-order features of these melodies is available, it would also be possible to examine which of the features contributing to perceived distinctiveness also predict an increased likelihood of plagiarism. This same process could also be followed to examine the role of idea valence in plagiarism, using those melodies rated in Study 1 as very high or very low in valence.

If strength in memory increases recognition plagiarism, as found in Study 3, then we would predict that, as distinctiveness improves recognition, this should also increase recall-own and recognition plagiarism. However, if strength in memory allows others' ideas to be better recognised (Stark et al., 2005), this same effect may result in distinctive melodies being better discriminated as computer-generated.

Likewise, in the generate-new phase, strength in memory should allow old ideas to better be rejected as earlier-created (Marsh & Bower, 1993; Stark et al., 2005). Thus, if distinctiveness facilitates recognition, we would expect that distinctiveness should reduce plagiarism. However, in Study 1, participant ratings of distinctiveness and valence were found to be correlated. We predict that valence should increase generate-new plagiarism, because the results of Study 3 suggest that liking increases generate-new plagiarism in both verbal and musical tasks. Thus, distinctiveness might also increase generate-new plagiarism.

A study examining the role of distinctiveness and valence in plagiarism would therefore contribute to further understanding of the mechanisms underlying plagiarism in musical and verbal tasks.

**Legal and professional implications of this research for unconscious plagiarism cases**

The findings of Studies 3 and 4 investigating unconscious plagiarism have substantial implications for the ways in which such cases are handled in court. At present, legislation treats unconscious and deliberate copying as if they were the same. *Fair dealing* provisions in the UK Copyright, Design and Patents Act 1988 (Legislation.gov.uk, 2018) and the Australian Copyright Act 1968 (Cth), and *fair use* provisions in the US Copyright Act of 1976 (2016) provide exceptions for certain types of copying (e.g., research, criticism, parody), but do not permit unconscious plagiarism. Rulings for both unconscious and deliberate copying involve the award of songwriting credit and payment of retrospective royalties to the plaintiff (e.g., *Bright Tunes Music Corp v Harrisongs Music Pty Ltd*., 1976; which was ruled to be a case of unconscious plagiarism, Müllensiefen & Pendzich, 2009).

Expert analysis of the degree of similarity between two works is normally provided by musicologists (Cason & Müllensiefen, 2012). While a musicologist is able to describe according to Western music theory those elements of a piece which are similar to another, they are unable to comment on the psychological processes involved in unconscious plagiarism. It remains surprising that while the plaintiff in a musical copyright case must establish that the defendant copied a “substantial part” of their work, copyright decisions are not informed at present by scientific understanding of the perception of similarity, or what a listener is capable of perceiving as substantial copying (Cason & Müllensiefen, 2012). As these studies represent the first investigation of unconscious plagiarism using a musical task, the understanding gained in these studies of the cognitive mechanisms involved in unconscious plagiarism in music may potentially be used to inform legal decision-making.

Legal investigations of unconscious plagiarism can have enormous consequences for both the professional and personal lives of the musicians involved. Financial settlements for plagiarism of a pop song can often amount to several million dollars (AFP, 2015), but the personal impact of such high-profile investigations can also be considerable. Australian band Men at Work were sued in 2010 by Larrikin Music over the use of an excerpt from the folk song “Kookaburra” in the flute solo from their song “Down Under” (*Larrikin Music Publishing Pty Ltd v EMI Songs Australia Pty Limited FCA 29,* 2010). Songwriter Colin Hay described the quotation by flautist Greg Ham as an inadvertent, unconscious reference, which the band themselves did not recognize for over twenty years (Hay, 2010). “Kookaburra” was originally written by Marion Sinclair in 1932 for a Girl Guides competition (Australian Associated Press, 2009), and is a well-known Australian folk song, learned by children at school, and commonly sung around the campfire. The case and subsequent appeals attracted considerable media attention, which caused Ham to fear that he would be remembered as a musician primarily for copying the song (Adams, 2015). Ham experienced depression following the case and his drug and alcohol dependency issues intensified (Northover & Johnson, 2012; Pena, 2014). His death in 2012 was initially reported in the media to be caused by a heart attack related to his drug use (Northover & Johnson, 2012), but was later acknowledged by Hay in a newspaper interview to be suicide (Mathieson, 2013).

Our research provides evidence that musicians are highly vulnerable to unconscious plagiarism, potentially more so than authors, because the mechanisms facilitating plagiarism in these domains differ. Plagiarism in verbal tasks is also difficult to avoid, but a single mechanism, idea improvement, has been identified to facilitate source confusion (Perfect & Stark, 2008a). Where teamwork involving extended idea improvement takes place, authors are best advised to take careful notes of the source of ideas during the generation process, as source errors may inflate to a near 50% rate (Stark & Perfect, 2008).

In Study 3, we found that plagiarism of music is facilitated by exposure, therefore no single task can be identified or avoided by musicians. Unconscious plagiarism can occur even after re-exposure through simple listening tasks, and trained musicians were as vulnerable to plagiarism as non-experts. Plagiarism in music is therefore extremely difficult to avoid. Certainly, musicians cannot be expected to avoid exposure to music when listening to others' music is an integral part of musical practice (Rosenthal et al., 1988). Repeated exposure via radio airplay was acknowledged to be the means by which George Harrison inadvertently copied the melody of The Chiffon's "He's So Fine" in his song "My Sweet Lord" (*Bright Tunes Music Corp v Harrisongs Music, Ltd.*, 1976; Müllensiefen & Pendzich, 2009). Given that Greg Ham's bandmates described his quotation of such a well-known folk song as an unconscious reference which they themselves did not immediately recognize (Hay, 2010), it is likely that this case was also an incidence of unconscious plagiarism through repeated exposure.

In Study 4, we found further evidence that plagiarism in music is difficult to avoid, as the intervention that we developed failed to reduce plagiarism. Generate-new plagiarism ranged from 10-35%, and as for Study 3, in the recognition test all participants claimed at least one of the computer-generated melodies was their own. Participant familiarity ratings functioned as a measure of memory strength in this study. These revealed a potential reason that the intervention did not affect plagiarism, as administration of the intervention after idea generation and elaboration did not alter familiarity. While consideration must still be given to developing an effective distractor task of appropriate length and format, one possibility which we considered is that, by the time ideas have been generated and elaborated, memory strength as well as source monitoring errors or failures are already well consolidated.

Thus Landau and Marsh (1997)'s suggestion that creative artists should carefully scrutinize idea sources following generation is unlikely to be helpful for musicians. Our conclusion following Study 4 accords with Stark and colleagues (2008) who suggested that after extended idea elaboration has taken place, source judgements are unlikely to be correct. In music, an additional difficulty is presented if contextual source cues are unattended to, and thus unavailable at recall to aid in source monitoring.

Indeed, although studies in verbal tasks have identified ways in which to improve participant source monitoring (Hollins et al., 2016; Macrae et al., 1999), no laboratory based studies of unconscious plagiarism have yet succeeded in removing incidences of plagiarism altogether. Unconscious plagiarism still occurs even when participants are strictly admonished not to plagiarize, offered financial incentives not to plagiarize (Stark et al., 2005), when they are held accountable for plagiarism, when contextual cues involved in source monitoring are increased, and when item-specific processing is increased through negative mood (Gingerich & Dodson, 2013; Hollins et al., 2016; Macrae et al., 1999; Stark et al., 2005; Weidler et al., 2012).

Taken together with the results of the present research, these findings may offer a potential explanation for the large number of court cases involving professional musicians which have recently been reported in the media (USC Gould School of Law, 2012). Further, this body of research highlights the difficulties faced by composers under present legislation, if unconscious plagiarism is extremely difficult to avoid. Given the professional and personal impact that a high-profile copyright case such as that of Men at Work may have on a musician's life, it is important that policy makers consider the degree to which a musician is held responsible when it can be established that plagiarism occurred unconsciously. If plagiarism in music is inevitable, as shown by the 100% rate of source errors in Experiment 2 of Study 3 and Study 4, and unavoidable, as shown in Study 4, consideration must be given to differentiating rulings in unconscious plagiarism cases from those where deliberate copying is established.

**Using technological measures to avoid plagiarism.** If plagiarism in music is difficult to avoid, musicians might consider using a technological application to identify plagiarism in their work. This is an area of research which has received increasing attention in the computer sciences (e.g., de Prisco et al., 2016; de Prisco, Malandrino, Zaccagnino, & Zaccagnino, 2017a, 2017b). Under the United States Online Copyright Infringement Liability Limitation Act (2016), online service providers are required to implement technological measures to identify and remove copyrighted material uploaded by subscribers in order to maintain *safe harbor* provisions against copyright infringement (Agrapidis, 2017). For example, SoundCloud uses a service called *Audible Magic*, which generates a digital fingerprint from analysis of an audio file (Agrapidis, 2017).

However, these measures are not without their flaws. Audible Magic has been shown to produce inconsistent matches, detecting some instances of sampling but not others (Agrapidis, 2017). Further, users have reported that the algorithm can be fooled by simple manipulations such as adding white noise or silence to the beginning of a file (Serato Forum, 2012). False positive matches are also common, with users finding that their original compositions have been removed for alleged copyright infringement. YouTube's *Content ID* service uses similar technology to identify infringing videos. This was recently reported to have identified and removed a 10-hour long video containing only computer-generated white noise as infringing the copyright of multiple artists (Donoughue, 2018).

The SIMILE (Müllensiefen & Frieler, 2006a) application used to identify instances of musical similarity in this series of studies shows a high degree of accuracy, correctly classifying 18 of 20 (90%) real-world copyright cases (Müllensiefen & Pendzich, 2009). This software is available for use by researchers on request. However, the current release is only capable of comparing monophonic melodies (Müllensiefen & Frieler, 2006b). The Frauenhofer Institute for Digital Media Technology (2016; 2014) has developed a suite of tools intended to detect of sampling as well as unintended incidences of plagiarism in original polyphonic music. However, this is a commercial software application intended for use by broadcasters and record companies, the cost of which a musician must consider against the risk of prosecution. While this demonstrates that technological measures have progressed to the degree that they are available commercially, the above reports of false positive infringement notifications as well as the ease by which detection can be evaded indicates that further research is needed before such technologies can be used by musicians in the same way that the Turnitin (1997) service is used to detect plagiarism in academic writing.

**Limitations of the present study**

**Limitations of the software and stimulus set.** As this was the first study of unconscious plagiarism using musical stimuli, to keep our design simple we used isochronic rhythm in all stimuli to focus on melodic copying only. While court cases in recent years have increasingly focused on copyright issues in rhythm and instrumentation (Associated Press, 2015), the majority of copyright infringement cases have involved instances where the melody is too similar to another previously composed work to have been generated independently (Müllensiefen & Pendzich, 2009). The MUSOS Toolkit (Rainsford, Palmer, & Paine, 2017) is therefore configured in its default setup for the study of isochronic stimuli. Isochronic stimuli are commonly used in music psychology studies which focus on attributes of melody alone (Halpern & Bower, 1982). However, some participants in Study 3, in particular those with expertise, commented that the lack of rhythm felt unrealistic, and that they often used rhythmic cues to aid memory. Further studies are therefore needed to investigate the separate contributions of rhythm, melody, and harmonic and tonal relationships to unconscious plagiarism.

**Testing of exposure effects.** One important limitation of Study 3 is that we did not test for mere exposure directly. When designing the study, we did not expect that the factors influencing plagiarism in music would differ to such an extent from verbal creative tasks. At this stage, no three-stage paradigm studies had been conducted outside of the verbal domain. We therefore focused initially on testing the conclusions of Stark and colleagues' research (2008) that improvement was the key factor affecting unconscious plagiarism. To keep our adaptation of the paradigm simple, we omitted the mere exposure condition as it had been found to have no effect on plagiarism (Stark et al., 2005).

However, when considering the nature of the imagery task in music, it can be seen to be an exposure-based task. Listening to and rating the effectiveness of verbal tasks involves conscious processing leading to the formation of strong memories (Stark et al., 2005). Picturing the object and its proposed use may also prime contextual cues reinforcing the original source who proposed the idea, further explaining the reduced plagiarism found in this condition.

As an adaption of this task to music, we asked our participants to listen to each melody and rate its effectiveness in conveying the mood of the poem, a task which may be undertaken passively without requiring elaborative processing. While the experience of music listening is often strongly associated with autobiographical memory (Krumhansl & Zupnick, 2013; Schulkind, Hennis, & Rubin, 1999), presentation on a computer reduces the availability of contextual cues (Marsh & Bower, 1993). Thus, although the imagery condition in music may be seen to primarily involve exposure, further studies should incorporate a passive listening exposure condition as well as testing imagery by rating melodies. A further test of increasing levels of exposure, similar to the repeated elaboration studies of Stark and Perfect (2008), would also determine whether unconscious plagiarism is increased in music following repetitive exposure. This would be of particular interest given the repetitive playlists used in popular radio and the availability of music streaming services.

**Understanding recall-own plagiarism in music.** In Experiment 1 of Study 3, no effect of elaboration was found on recall-own plagiarism. This was surprising in comparison with studies in verbal tasks. At that stage of the experiment, we had found some effect of the elaboration conditions on generate-new plagiarism, and therefore attributed the null effect in the recall-own phase to be due to the difficulty of recalling six newly-composed melodies. While participants commented on this factor, other studies incorporating a recall-own phase have used a free- rather than forced-report method, as forced recall encourages guessing and thus reporting of items that the participant has relatively low confidence in being their own (Hollins et al., 2016; Perfect & Stark, 2008a; Stark et al., 2005). Data from free-report studies of the recall-own phase therefore can be dirty, so these studies require large sample sizes (Hollins & Lange, 2016). With a larger sample size and a free-report method, we may gain further understanding of factors influencing plagiarism in the recall-own phase. However, these are still unlikely to involve elaboration, as forced-report studies investigating source monitoring effects on plagiarism still show the same overall pattern as those which use free-report methods (Hollins et al., 2016; Macrae et al., 1999).

Future research into recall-own plagiarism in music should therefore focus on other factors which have influenced plagiarism, such as social, mood or valence-based influences (Bink et al., 1999; Gingerich & Dodson, 2013; Hollins et al., 2016; Perfect et al., 2009; Perfect & Stark, 2008b). Of these three possibilities, manipulation of mood would be the most likely to be effective as positive mood was successful in increasing plagiarism through increased heuristic processing in the recall-own phase (Gingerich & Dodson, 2013). While social factors such as partner absence and same-sex pairs also increased recall-own plagiarism, this was due to the source-monitoring focus of verbal plagiarism (Hollins et al., 2016; Macrae et al., 1999) and thus would be unlikely to be effective in music, where acquisition of source traces appears to be limited. Johnson and colleagues (1993) suggested that when source information is not accessed, familiarity-based heuristic processing may be used to infer source, a proposal that would be consistent with our findings in Study 3. We would therefore expect that increased heuristic processing through the induction of positive mood should also increase plagiarism in music.

In verbal studies, plagiarism of high-quality ideas occurred only in the generate-new phase (Perfect & Stark, 2008b), and participants were also more likely to plagiarize an expert source during the generate-new phase only (Bink et al., 1999; Perfect et al., 2009). Perfect and Stark (2008b) argued that this effect was due to participants rejecting candidate ideas of low valence, and producing at test only those ideas that they thought to be of better quality. Despite the likelihood that idea valence may likewise only influence generate-new plagiarism in music (as we found evidence for in Study 3), such idea selection processes are involved in both the recall and generation of ideas during real-world composition. We therefore recommend testing for effects of expertise of the source of ideas in future studies of music plagiarism.

**Expertise of participants.** In the present study, it was not possible to adhere to a strict delineation between expert and non-expert participants due to the small population of musicians available in Tasmania. Study 1 of Experiment 3 incorporated only musicians with AMEB Stage 1 or below in the non-expert category, but we had to relax this criterion in Study 2 to recruit a large enough sample of non-expert musicians. However, Study 2 also incorporated a greater range of experience within the expert sample. While Study 1 involved mostly Conservatorium students (a number of whom had not received 10 years' lessons, but qualified as expert under the alternative criteria of passing the Conservatorium entry examination), many of the expert musicians who participated in Study 2 had over 40 years of experience as professional musicians. We therefore believe the delineation between the two groups was sufficient in both studies to detect an effect.

The null effect of expertise in our study was consistent with the findings of Patihis and colleagues (2013) in false memory studies, but was not consistent with the expert memory effect elicited by Dow (2015). While her sample did not use Ericsson and colleagues' (1993) definition of 10 years of intensive practice, but instead contrasted Masters' level students (with a minimum of 5 years study) and first-year undergraduates, these criteria would have obtained a cleaner delineation between groups. Further studies are therefore needed to confirm whether expertise influences the likelihood of music plagiarism. We can, however, conclude that we found no evidence of a difference between expert and non-expert musicians across two studies, thus, considerations must be given to the way in which unconscious plagiarism cases are handled in court, as sentencing is currently similar to cases where deliberate copying has occurred (Müllensiefen & Pendzich, 2009).

**Compliance issues in using an intervention to avoid plagiarism.** One potential reason that the intervention tested in Study 4 may have failed to reduce plagiarism was the short duration of the distractor task. For ethical reasons, we decided to administer the task for no longer than two minutes, as participants at this stage of the experiment had no knowledge of the purpose of the task, and it might sound dissonant to a listener. Indeed, many participants reported that the randomly generated notes sounded strange and unpleasant. Atonal music (music which is designed to violate diatonic tonal relationships by the use of equal repetitions of the 12-note chromatic scale) is rated by both trained and untrained listeners as less pleasant, and less emotionally arousing than tonal music (Daynes, 2010; Droit-Volet, Ramos, Bueno, & Bigand, 2013). If a longer distractor task is found to reduce plagiarism, consideration must be given to the degree with which musicians are likely to comply with using such an intervention. When copyright regulations present a barrier to creativity, contemporary artists have a tendency through their work to push such boundaries and to press for changes to the law, rather than comply with existing legislation (Lessig, 2008). If an effective distractor task was to be developed, the convenience of a simple listening-based intervention might be sufficient for those musicians who are more concerned about the likelihood of a lawsuit. However, further studies are recommended to investigate methods of avoiding plagiarism which are more enjoyable and thus more likely to be used by musicians.

**Conclusion**

This thesis provides a method for conducting studies of memory for music in the general population as well as trained musicians, and a demonstration of the effectiveness of this method in the first study showing that the distinctiveness effect, as observed in other domains, generalizes to the recognition of whole melodies. Further, in two studies using this computer-based method to test unconscious plagiarism using a musical task, this thesis provides the first evidence that the factors influencing unconscious plagiarism in music differ to those identified in verbal tasks. In music, unconscious plagiarism occurs through simple re-exposure to ideas, thus, musicians appear to be more susceptible to plagiarism than previously understood from Stark and colleagues' research (Perfect & Stark, 2008a; Stark & Perfect, 2006, 2008; 2005). This finding has considerable implications for the legal handling of such cases, which are at present treated as if the musician had deliberately copied the work. The level of risk faced by musicians is further demonstrated in these first studies investigating the role of expertise in plagiarism using the three-stage paradigm, as expert musicians were as susceptible as non-experts to unconscious plagiarism.

One of the most important contributions of the present research to the literature is in establishing the beginnings of a model describing unconscious plagiarism across domains. The dissociation known to exist between factors which facilitate implicit and explicit memory appears to extend to unconscious plagiarism. Where implicit memory is primarily employed, such as in musical tasks, plagiarism increases through exposure, whereas where explicit, elaborative processing is predominantly used in verbal tasks, plagiarism increases via improvement of others ideas, and source monitoring processes are predominantly involved.

This model allows us to make and test predictions regarding the factors which are associated with unconscious plagiarism in other creative domains such as visual art and dance. The model further incorporates those factors which increase and reduce the risk of plagiarism in implicit and explicit memory-based tasks, allowing for greater understanding of the extent to which creative artists across domains should be expected to avoid plagiarism, and those steps which may be taken to reduce the risk of plagiarism. Although an effective intervention strategy to address unconscious plagiarism in music is yet to be developed, our research is consistent with studies in the verbal domain which show that unconscious plagiarism is highly common, and difficult to avoid. Together with the overall finding that exposure increases musical plagiarism, this research further contributes to the primary finding in the literature of unconscious plagiarism across the past thirty years which shows that there is no means by which a creative artist may entirely evade the risk of unconscious plagiarism. The way forward, therefore, lies in better understanding of those factors which lead to the occurrence of unconscious plagiarism, in order that the scientific understanding gained from these investigations may better inform legal decision-making.

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Appendix 1 has been removed for copyright or proprietary reasons.

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**Appendix 2.1** Study 3 Experiment 1 Forms

## Pre-Study Information Sheet for Non-Expert Musicians

*University of Tasmania*
*School of Psychology*

UTAS

*Participant Information Sheet version 1 30 April 2013*

# Cognition in music

Information Sheet for Participation in a Research Project

### 1. Invitation

You are invited to participated in a research study into various aspects of music cognition, including the effects of time delays, on the completion of a creative task.

This study is being conducted in partial fulfillment of a Honours degree in Psychology for Ms. Miriam Rainsford under the supervision of Dr. Matthew Palmer.

### 2. What is the purpose of this study?

The purpose of this study is to investigate the effect of various aspects of music cognition, including the effects of time delays, on the completion of a creative task. Creativity has been observed to occur in cycles, with moments of illumination, or 'lightbulb moments', being those at which a breakthrough in creativity occurs. These have often been observed to occur at the point at which one takes a break from working at a creative task. For this reason we will be conducting the study across two sessions separated by 24 hours, to study the effect of time delays on creativity.

### 3. Why have I been invited to participate?

You are eligible to participate in this study as an amateur musician aged between 18-60 years who has received up to three years of private music lessons, or has studied a musical instrument at school, but has not performed professionally or as a member of a band.

It is important that you understand that your participation in this study is voluntary. You may choose to leave the study at any time, without being required to provide an explanation. Your contact details and the data recorded during the experiment will be treated in a confidential manner, and will be assigned a unique participant number. The researchers will not have access to your personal contact details, and your name will not be used in any publications following the research.

### 4. What will I be asked to do?

You will be asked to compose, listen to, and edit melodies using a computer program, across two sessions of data collection.

You will be given an Arabic musical scale, known as a 'maqam', and a classical Arabic poem. You will be asked to compose melodies to suit your interpretation of the poem using a computer program, and to listen to and edit melodies generated by the computer.

Each session is expected to take around one hour. No information will be recorded other than your responses to the computer program, and a short demographic questionnaire on your music listening habits and interests, and length of musical training.

*University of Tasmania*
*School of Psychology*

*Participant Information Sheet version 1 30 April 2013*

### 5. Are there any possible benefits from participation in this study?
You will gain experience in research procedures involved in the study of music cognition. The information gained by the researchers will help to confirm the results of previous experiments, and will further the understanding of creative processes in music.

### 6. Are there any possible risks from participation in this study?
There are no known risks involved in participation in this study.

### 7. What if I change my mind during or after the study?
You are free to withdraw from this study at any time, and you do not have to provide a reason if you decide to leave the study. If you choose to leave the study after completing the experiment, you will not be able to withdraw your data because it will be anonymous.

### 8. What will happen to the information when this study is over?

Your information will be stored on a password protected computer at the School of Psychology, available only to the researchers. All personally identifiable information will be removed, and future reference to your data will be by participant number only. The researchers have access to a list of participant names and unique identifiers so that study may be resumed the following day. This list is stored securely on a password protected computer in the School of Psychology, to which only the researchers have access. No personal information other than your name and the unique identifier that you have been assigned is stored in this list.

Your data will be kept for a minimum of five (5) years following the study, in accordance with University and National requirements, after which time it will be securely disposed of.

### 9. How will the results of the study be published?
The results of the study will be published as Miriam Rainsford's Honours thesis. A copy of this study will be stored in the University of Tasmania Morris Miller Library. The results will also be submitted for publication in an academic journal. You may request a copy of the results of the study. Participants' data will not be identifiable in the publication.

### 10. What if I have questions about this study?
If you would like further information, please contact:

Ms. Miriam Rainsford (maec@utas.edu.au)
Dr. Matt Palmer (03 6324 3004 or matthew.palmer@utas.edu.au)

If you are a student of the University of Tasmania, you may wish to discuss any concerns in confidence with a University Student Counsellor. This service is free of charge, tel. (03) 6226 2697.

This study has been approved by the Tasmanian Social Sciences Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, please contact the Executive Officer of the HREC (Tasmania) Network on (03) 6226 7479 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. Please quote ethics reference number H13235.

*University of Tasmania*
*School of Psychology*

*Participant Information Sheet version 1 30 April 2013*

**This information sheet is yours to keep following the study.**

**Thank you for taking the time to consider this study. If you wish to take part in the study, please sign the attached consent form.**

## Pre-Study Information Sheet for Expert Musicians

*University of Tasmania*
*School of Psychology*

*Participant Information Sheet version 1 30 April 2013*

# Cognition in music

Information Sheet for Participation in a Research Project

### 1. Invitation

You are invited to participated in a research study into various aspects of music cognition, including the effects of time delays, on the completion of a creative task.

This study is being conducted in partial fulfillment of an Honours degree in Psychology for Ms. Miriam Rainsford under the supervision of Dr. Matthew Palmer.

### 2. What is the purpose of this study?

The purpose of this study is to investigate the effect of various aspects of music cognition, including the effects of time delays, on the completion of a creative task. Creativity has been observed to occur in cycles, with moments of illumination, or 'lightbulb moments', being those at which a breakthrough in creativity occurs. These have often been observed to occur at the point at which one takes a break from working at a creative task. For this reason we will be conducting the study across two sessions separated by 24 hours, to study the effect of time delays on creativity.

### 3. Why have I been invited to participate?

You are eligible to participate in this study as someone who is aged between 18-60 years, with professional musical expertise, either through 10 or more years of music study, or as a current or former student of the Tasmanian Conservatorium of Music.

It is important that you understand that your participation in this study is voluntary. You may choose to leave the study at any time, without being required to provide an explanation. Your contact details and the data recorded during the experiment will be treated in a confidential manner, and will be assigned a unique participant number. The researchers will not have access to your personal contact details, and your name will not be used in any publications following the research.

### 4. What will I be asked to do?

You will be asked to compose, listen to, and edit melodies using a computer program, across two sessions of data collection.

You will be given an Arabic musical scale, known as a 'maqam', and a classical Arabic poem. You will be asked to compose melodies to suit your interpretation of the poem using a computer program, and to listen to and edit melodies generated by the computer.

Each session is expected to take around one hour. No information will be recorded other than your responses to the computer program, and a short demographic questionnaire on your music listening habits and interests, and length of musical training.

*University of Tasmania*
*School of Psychology*

*Participant Information Sheet version 1 30 April 2013*

**5. Are there any possible benefits from participation in this study?**
You will gain experience in research procedures involved in the study of music cognition. The information gained by the researchers will help to confirm the results of previous experiments, and will further the understanding of creative processes in music.

**6. Are there any possible risks from participation in this study?**
There are no known risks involved in participation in this study.

**7. What if I change my mind during or after the study?**
You are free to withdraw from this study at any time, and you do not have to provide a reason if you decide to leave the study. If you choose to leave the study after completing the experiment, you will not be able to withdraw your data because it will be anonymous.

**8. What will happen to the information when this study is over?**
Your information will be stored on a password protected computer at the School of Psychology, available only to the researchers. All personally identifiable information will be removed, and future reference to your data will be by participant number only. The researchers have access to a list of participant names and unique identifiers so that study may be resumed the following day. This list is stored securely on a password protected computer in the School of Psychology, to which only the researchers have access. No personal information other than your name and the unique identifier that you have been assigned is stored in this list.

Your data will be kept for a minimum of five (5) years following the study, in accordance with University and National requirements, after which time it will be securely disposed of.

**9. How will the results of the study be published?**
The results of the study will be published as Miriam Rainsford's Honours thesis. A copy of this study will be stored in the University of Tasmania Morris Miller Library. The results will also be submitted for publication in an academic journal. You may request a copy of the results of the study. Participants' data will not be identifiable in the publication.

**10. What if I have questions about this study?**
If you would like further information, please contact:

Ms. Miriam Rainsford (maec@utas.edu.au)
Dr. Matt Palmer (03 6324 3004 or matthew.palmer@utas.edu.au)

If you are a student of the University of Tasmania, you may wish to discuss any concerns in confidence with a University Student Counsellor. This service is free of charge, tel. (03) 6226 2697.

This study has been approved by the Tasmanian Social Sciences Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, please contact the Executive Officer of the HREC (Tasmania) Network on (03) 6226 7479 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. Please quote ethics reference number H13235

*University of Tasmania*
*School of Psychology*

*Participant Information Sheet version 1 30 April 2013*

**This information sheet is yours to keep following the study.**

**Thank you for taking the time to consider this study. If you wish to take part in the study, please sign the attached consent form.**

## Pre-Study Consent Form

*University of Tasmania*
*School of Psychology*

*Participant Consent Form version 1 30 April 2013*

# Cognition in music

Participants Consent Form

1. I agree to take part in the research study named above.
2. I have read and understood the Information Sheet for this study.
3. The nature and possible effects of the study have been explained to me.
4. I understand that the study involves composing and listening to melodies using a computer program, during two sessions separated by 24 hours.
5. I understand that there are no foreseeable risks associated with participation in this study.
6. I understand that all research data will be securely stored on the University of Tasmania premises for five years from the publication of the study results, and will then be destroyed unless I give permission for my data to be archived.

   I agree to have my study data archived.

   Yes ☐ No ☐
7. Any questions that I have asked have been answered to my satisfaction.
8. I understand that the researcher(s) will maintain confidentiality and that any information I supply to the researcher(s) will be used only for the purposes of the research.
9. I understand that the results of the study will be published so that I cannot be identified as a participant.
10. I understand that my participation is voluntary and that I may withdraw at any time without any effect.
11. I understand that the data collected from me will be assigned a unique numerical identifier, so that the study may be resumed the following day. I understand that only the researcher(s) have access to the list of participant names and unique identifiers, and that no personal information is associated with this list.
12. I understand that I will not be able to withdraw my data after the data analysis process has begun because it will be analysed anonymously.

Participant's name: ____________________________________________

Participant's signature: _________________________________________

*University of Tasmania*
*School of Psychology*

*Participant Consent Form version 1 30 April 2013*

Date: ________________________

**Statement by Investigator**

☐ I have explained the project and the implications of participation in it to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation.

If the Investigator has not had an opportunity to talk to participants prior to them participating, the following must be ticked.

☐ The participant has received the Information Sheet where my details have been provided so participants have had the opportunity to contact me prior to consenting to participate in this project.

Investigator's name: ________________________________________________

Investigator's signature: ____________________________________________

Date: ________________________

## Post-Study Information Sheet for All Participants

1

# Unconscious plagiarism in music: Source monitoring and the effects of musical expertise

Information Sheet following Participation in a Research Project

### 1. The purpose of the study

The purpose of this study was to investigate cognitive factors that cause people to confuse melodies they themselves generated with melodies generated by a computer. This type of memory confusion can be thought of as "unconscious plagiarism". The study used a procedure developed by researchers at the University of Plymouth (Stark and Perfect, 2006), which has been used to study unconscious plagiarism in verbal creative tasks. The idea behind the procedure is that editing and reworking ideas that were originally created by others increases the possibility that a person will later unconsciously reproduce these ideas in their own work. This occurs because the cognitive processes involved in creating original ideas and reworking others' ideas are very similar. Some experts think that this offers an explanation for famous cases of music plagiarism such as Bright Tunes Music Corp. v. Harrisongs Music Ltd (1967), where George Harrison's song 'My Sweet Lord' was found to have unconsciously plagiarised The Chiffons' 'He's So Fine' (Perfect & Stark, 2008).

The effectiveness of this procedure has been replicated numerous times in creative tasks, but has never been tested in music. The primary purpose of this experiment was therefore to obtain experimental evidence as to whether the paradigm truly explains the circumstances under which unconscious plagiarism occurs in music.

In addition, this study also investigated whether expert recall affects the likelihood of unconscious plagiarism. For this reason we will be comparing the results of a group of professional musicians against those from a group of amateur musicians. Recognition of information in a domain in which one has expertise has been shown to be greatly improved (Rawson & Overschelde, 2008; Bailes, 2010). We therefore expect that professional musicians will have lower rates of unconscious plagiarism, as they will be better able to discriminate their own work from the melodies generated by the computer.

### 2. Important information

It is important to understand that the procedure used in this study is specifically designed to promote confusion between self-generated melodies and melodies generated by the computer. In other words, you can think of the study as a set-up designed to maximise the chances that participants would unconsciously "plagiarise" melodies. Please understand that the responses made by participants in the study do not in any way reflect badly on any individual's creative ability or ethics as a musician.

1

### 3. How will the data collected from me in this study be analysed?

It is important to remember that all melodies included for analysis in this study will be anonymous. That is, if you consent to including your melodies being including in the study for analysis, there will be no way of identifying them as being generated by you.

We will be analysing all of the melodies created, including the melodies composed and modified in the first session, and the melodies recalled and composed in the second session, using a statistical process called 'similarity analysis'. Melodies generated by participants will be compared against the computer-generated melodies to identify whether any of the pieces created by participants were similar to those created by the computer, and if so, to what degree. The results of the recognition test from the second session will also be examined to test whether participants accidentally remembered any of the computer's melodies as their own, or vice versa.

You are free to request a copy of the results of this study once the analysis has been conducted. If you wish to do so, please contact either Ms. Rainsford or Dr. Palmer by telephone or email using the contact information provided below.

It is important that you understand that your participation in this study is voluntary. You are free to withdraw from participation without being required to provide an explanation. Your contact details and the data recorded during the experiment will be treated in a confidential manner, and will not be passed on to any person or organization other than the researchers directly involved in this study.

Your data has been assigned a unique participant number, rather than being stored with any identifying information. The researchers have access to a list of the participants names and unique identifiers, so that the study could be resumed the following day, and so that you may have the opportunity to decide whether to consent to your data being used now that you have been informed of the full purpose of the study. This list of unique identifiers is stored on a password protected computer to which only the researchers have access. No personal information other than your name and the unique identifier that you have been assigned is stored in this list. The researchers do not have access to your personal contact details, and your name will not be used in any publications following the research.

### 4. What are the benefits of this study?

The information gained by the researchers will help to confirm the hypothesis of Stark and Perfect (2006) that the Plymouth paradigm provides an explanation of the circumstances under which unconscious plagiarism occurs in music. In addition, the study will examine whether expertise in music reduces the likelihood of unconscious plagiarism.

### 5. Are there any possible risks from participation in this study?

There are no known risks involved in participation in this study. However, if you feel any discomfort as a result of having participated in this study, we are able to arrange for you to discuss any concerns in confidence with a University Student Counsellor. This service is free of charge, tel. (03) 6226 2697.

**6. What if I have changed my mind?**

You are free to withdraw your consent for the data collected from you to be used at any time. You do not have to provide a reason if you decide to leave the study.

If you choose to leave the study, any data that has been collected from you will be removed from the study. Bear in mind that any data that has been stored in anonymous form e.g., once we have begun the process of analysing the melodies, will not be able to be identified for removal.

**7. What if I have questions about this study?**

If you would like further information, or have any questions about this study, please feel free to contact:

Ms. Miriam Rainsford (maec@utas.edu.au)
Dr. Matthew Palmer (03 6324 3004 or matthew.palmer@utas.edu.au)

If you would like to discuss any concerns you may have about the study in confidence, you may wish to contact the University's Counselling service. This service is free of charge, tel. (03) 6226 2697.

This study has been approved by the Tasmanian Social Sciences Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, please contact the Executive Officer of the HREC (Tasmania) Network on (03) 6226 7479 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. Please quote ethics reference number H13235.

**This information sheet is yours to keep.**

**Thank you for taking the time to consider this information. If you are happy for the data collected from you during the study to be used, please sign the attached consent form.**

**References:**

Bailes, F. (2010). Dynamic melody recognition: Distinctiveness and the role of musical expertise. *Memory and Cognition, 38,* 641-650. doi:10.3758/MC.38.5.641

Bright Tunes Music Corp. v. Harrisongs Music, Ltd. (1976). Retrieved 7 April, 2013, from http://www.law.berkeley.edu/files/Bright_Tunes_Music_v_Harrisongs.pdf

Perfect, T J., & Stark, L-J. (2008). Tales from the crypt… omnesia, in J. Dunlosky & R. Bjork (Eds.), *A handbook of memory and metamemory*. New York: LEA, pp. 285-314.

Rawson, K. A., & Overschelde, J. P. (2008). How does knowledge promote memory? The distinctiveness theory of skilled memory. *Journal of Memory and Language, 58,* 646-668. doi:10.1016/j.jml.2007.08.004

Stark, L-J., & Perfect, T. J. (2006). Elaboration inflation: How your ideas become mine. *Applied Cognitive Psychology, 20,* 641-648. doi:10.1002/acp.1216

## Post-Study Consent Form

*University of Tasmania*
*School of Psychology*

*Participant Consent Form version 1 30 April 2013*

# Unconscious plagiarism in music: Source monitoring and the role of musical expertise

Participants Consent Form

1. I agree to take part in the research study named above.
2. I have read and understood the Information Sheet for this study.
3. The nature and possible effects of the study have been explained to me.
4. I understand that the data collected from me during the experimental sessions was for the purposes of studying unconscious plagiarism in music. I understand that the procedure used in this experiment was designed to maximise the chances of unconscious plagiarism. I understand that the melodies I have composed during the first and second sessions, and the information collected during the Recall test will be analysed for similarity against those generated by the computer.
5. I understand that there are no foreseeable risks associated with participation in this study.
6. I understand that all research data will be securely stored on the University of Tasmania premises for five years from the publication of the study results, and will then be destroyed unless I give permission for my data to be archived

   I agree to have my study data archived.

   Yes ☐ No ☐
7. Any questions that I have asked have been answered to my satisfaction.
8. I understand that the researcher(s) will maintain confidentiality and that any information I supply to the researcher(s) will be used only for the purposes of the research.
9. I understand that the results of the study will be published so that I cannot be identified as a participant.
10. I understand that my participation is voluntary and that I may withdraw at any time without any effect.
11. I understand that the data collected from me will be assigned a unique numerical identifier, so that the study may be resumed the following day, and so that I may have the opportunity to provide consent for the data collected from me to be used now that I am aware of the true purpose of the study. I understand that only the researcher(s) have access to the list of participant names and unique identifiers, and that no personal information is associated with this list.
12. I understand that I will not be able to withdraw my data after the data analysis process has begun because it will be analysed anonymously.

*University of Tasmania*
*School of Psychology*

*Participant Consent Form version 1 30 April 2013*

UTAS

Participant's name: ______________________________

Participant's signature: ______________________________

Date: ____________________

**Statement by Investigator**

☐ I have explained the project and the implications of participation in it to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation.

If the Investigator has not had an opportunity to talk to participants prior to them participating, the following must be ticked.

☐ The participant has received the Information Sheet where my details have been provided so participants have had the opportunity to contact me prior to consenting to participate in this project.

Investigator's name: ______________________________

Investigator's signature: ______________________________

Date: ____________________

## Questionnaire

*University of Tasmania*
*School of Psychology*

UTAS

### Cognition in music

Research Project Questionnaire

Participant No. ………… Age …………

For how many years have you played and/or composed music?

…………………………………………………………………………………………

Have you taken music lessons privately? If so, for how many years did you have lessons?

…………………………………………………………………………………………

Did you study an instrument at high school? If so, for how many years did you have lessons?

…………………………………………………………………………………………

Have you ever performed live as a musician, or had your compositions released as a recording?

…………………………………………………………………………………………

What is your instrument/voice?

…………………………………………………………………………………………

Do you compose music?

…………………………………………………………………………………………

Do you perform or compose mainly classical, popular music or both?

…………………………………………………………………………………………

Do you prefer to listen to mainly classical, popular music, or both?

…………………………………………………………………………………………

How many hours per week would you spend listening to music?

…………………………………………………………………………………………

How many hours per week would you spend practicing or playing music?

…………………………………………………………………………………………

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*School of Psychology*

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Do you have absolute pitch ("perfect pitch")?

……………………………………………………………………………………………

Please rate your agreement with the following statements, on a scale of 1 to 7, where :

1 = strongly disagree
2 = disagree
3 = somewhat disagree
4 = neither agree or disagree
5 = somewhat agree
6 = agree
7 = strongly agree

There are no right or wrong answers, simply choose the number that best reflects your opinion.

"I enjoy using samples in my music, or listening to music made from samples or quotations of other peoples music"

……………………………………………………………………………………………

"Musicians should always compose original new works. Musicians should never copy or make reference to the work of another musician".

……………………………………………………………………………………………

"Mashups" and collages made from other people's work are art forms too. I don't think there is anything wrong with re-using someone else's work to make new art".

……………………………………………………………………………………………

"The work I do should always be 100% original"

……………………………………………………………………………………………

**Appendix 2.2** Study 3 Experiment 2 Forms

## Pre-study Information Sheet (24-hour delay)

*University of Tasmania*
*School of Psychology*

*Participant Information Sheet version 1 22 March 2014*

# Creativity and cognition in music - Study B

Information Sheet for Participation in a Research Project

### 1. Invitation

You are invited to participated in a research study into various aspects of music cognition, including the effects of time delays, on the completion of a creative task.

This study is being conducted in partial fulfillment of the degree of Doctor of Philosophy (PhD) in Psychology for Ms. Miriam Rainsford, under the supervision of Dr. Matthew Palmer.

### 2. What is the purpose of this study?

The purpose of this study is to investigate the effect of various aspects of music cognition, including the effects of time delays, on the completion of a creative task. Creativity has been observed to occur in cycles, with moments of illumination, or 'lightbulb moments', being those at which a breakthrough in creativity occurs. These have often been observed to occur at the point at which one takes a break from working at a creative task. For this reason we will be conducting the study across two sessions separated by 24 hours, to study the effect of time delays on creativity.

### 3. Why have I been invited to participate?

You are eligible to participate in this study as someone who is aged between 18-60 years, who has experience in playing music, e.g. has studied music at high school, or enjoys amateur music making at home or with a band.

It is important that you understand that your participation in this study is voluntary. You may choose to leave the study at any time, without being required to provide an explanation. Your contact details and the data recorded during the experiment will be treated in a confidential manner, and will be assigned a unique participant number. The researchers will not have access to your personal contact details, and your name will not be used in any publications following the research.

### 4. What will I be asked to do?

You will be asked to compose, listen to, and edit melodies using a computer program, across two sessions of data collection.

You will be given an Arabic musical scale, known as a 'maqam', and a classical Arabic poem. You will be asked to compose melodies to suit your interpretation of the poem using a computer program, and to listen to and edit melodies generated by the computer.

Each session is expected to take around one hour. No information will be recorded other than your responses to the computer program, and a short demographic questionnaire on your music listening habits and interests, and length of musical training.

*University of Tasmania*
*School of Psychology*

UTAS

*Participant Information Sheet version 1 22 March 2014*

**5. Are there any possible benefits from participation in this study?**
You will gain experience in research procedures involved in the study of music cognition. The information gained by the researchers will help to confirm the results of previous experiments, and will further the understanding of creative processes in music.

**6. Are there any possible risks from participation in this study?**
There are no known risks involved in participation in this study.

**7. What if I change my mind during or after the study?**
You are free to withdraw from this study at any time, and you do not have to provide a reason if you decide to leave the study. If you choose to leave the study after completing the experiment, you will not be able to withdraw your data because it will be anonymous.

**8. What will happen to the information when this study is over?**
Your information will be stored on a computer disk, with password protected access, available only to the researchers. All personally identifiable information will be removed, and future reference to your data will be by participant number only.

Your data will be kept for a minimum of five (5) years following the study, in accordance with University and National requirements, after which time it will be securely disposed of.

**9. How will the results of the study be published?**
The results of the study will be published as Miriam Rainsford's PhD thesis. A copy of this study will be stored in the University of Tasmania Morris Miller Library. The results will also be submitted for publication in an academic journal. You may request a copy of the results of the study. Participants' data will not be identifiable in the publication.

**10. What if I have questions about this study?**
If you would like further information, please contact:

Ms. Miriam Rainsford (03 6226 7458 or miriam.rainsford@utas.edu.au)
Dr. Matt Palmer (03 6324 3004 or matthew.palmer@utas.edu.au)

If you are a student of the University of Tasmania, you may wish to discuss any concerns in confidence with a University Student Counsellor. This service is free of charge, tel. (03) 6226 2697.

This study has been approved by the Tasmanian Social Sciences Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, please contact the Executive Officer of the HREC (Tasmania) Network on (03) 6226 7479 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. Please quote ethics reference number H12345

**This information sheet is yours to keep following the study.**

**Thank you for taking the time to consider this study. If you wish to take part in the study, please sign the attached consent form.**

**Pre-study Information Sheet (1-week delay)**

*University of Tasmania*
*School of Psychology*

*Participant Information Sheet version 1 22 March 2014*

## Creativity and cognition in music - Study B

Information Sheet for Participation in a Research Project

### 1. Invitation

You are invited to participated in a research study into various aspects of music cognition, including the effects of time delays, on the completion of a creative task.

This study is being conducted in partial fulfillment of the degree of Doctor of Philosophy (PhD) in Psychology for Ms. Miriam Rainsford, under the supervision of Dr. Matthew Palmer.

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### 3. Why have I been invited to participate?

You are eligible to participate in this study as someone who is over 18 years of age, and who has experience in playing music, e.g. has studied music at high school, or enjoys amateur music making at home or with a band.

It is important that you understand that your participation in this study is voluntary. You may choose to leave the study at any time, without being required to provide an explanation. Your contact details and the data recorded during the experiment will be treated in a confidential manner, and will be assigned a unique participant number. The researchers will not have access to your personal contact details, and your name will not be used in any publications following the research.

### 4. What will I be asked to do?

You will be asked to compose, listen to, and edit melodies using a computer program, across two sessions of data collection.

You will be given an Arabic musical scale, known as a 'maqam', and a classical Arabic poem. You will be asked to compose melodies to suit your interpretation of the poem using a computer program, and to listen to and edit melodies generated by the computer.

Each session is expected to take around one hour. No information will be recorded other than your responses to the computer program, and a short demographic questionnaire on your music listening habits and interests, and length of musical training.

*University of Tasmania*
*School of Psychology*

*Participant Information Sheet version 1 22 March 2014*

**5. Are there any possible benefits from participation in this study?**
You will gain experience in research procedures involved in the study of music cognition. The information gained by the researchers will help to confirm the results of previous experiments, and will further the understanding of creative processes in music.

**6. Are there any possible risks from participation in this study?**
There are no known risks involved in participation in this study.

**7. What if I change my mind during or after the study?**
You are free to withdraw from this study at any time, and you do not have to provide a reason if you decide to leave the study. If you choose to leave the study after completing the experiment, you will not be able to withdraw your data because it will be anonymous.

**8. What will happen to the information when this study is over?**
Your information will be stored on a computer disk, with password protected access, available only to the researchers. All personally identifiable information will be removed, and future reference to your data will be by participant number only.

Your data will be kept for a minimum of five (5) years following the study, in accordance with University and National requirements, after which time it will be securely disposed of.

**9. How will the results of the study be published?**
The results of the study will be published as Miriam Rainsford's PhD thesis. A copy of this study will be stored in the University of Tasmania Morris Miller Library. The results will also be submitted for publication in an academic journal. You may request a copy of the results of the study. Participants' data will not be identifiable in the publication.

**10. What if I have questions about this study?**
If you would like further information, please contact:

Ms. Miriam Rainsford (03 6226 7458 or miriam.rainsford@utas.edu.au)
Dr. Matt Palmer (03 6324 3004 or matthew.palmer@utas.edu.au)

If you are a student of the University of Tasmania, you may wish to discuss any concerns in confidence with a University Student Counsellor. This service is free of charge, tel. (03) 6226 2697.

This study has been approved by the Tasmanian Social Sciences Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, please contact the Executive Officer of the HREC (Tasmania) Network on (03) 6226 7479 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. Please quote ethics reference number H12345

**This information sheet is yours to keep following the study.**

**Thank you for taking the time to consider this study. If you wish to take part in the study, please sign the attached consent form.**

## Pre-study Consent Form (24-hour delay)

*University of Tasmania*
*School of Psychology*

*Participant Consent Form version 1 22 March 2014*

UTAS

### Creativity and cognition in music – Study B

Participants Consent Form

1. I agree to take part in the research study named above.
2. I have read and understood the Information Sheet for this study.
3. The nature and possible effects of the study have been explained to me.
4. I understand that the study involves composing and listening to melodies using a computer program, during two sessions separated by 24 hours.
5. I understand that there are no foreseeable risks associated with participation in this study.
6. I understand that all research data will be securely stored on the University of Tasmania premises for five years from the publication of the study results, and will then be destroyed unless I give permission for my data to be archived.

   I agree to have my study data archived.

   Yes ☐ No ☐
7. Any questions that I have asked have been answered to my satisfaction.
8. I understand that the researcher(s) will maintain confidentiality and that any information I supply to the researcher(s) will be used only for the purposes of the research.
9. I understand that the results of the study will be published so that I cannot be identified as a participant.
10. I understand that my participation is voluntary and that I may withdraw at any time without any effect.

    I understand that I will not be able to withdraw my data after completing the experiment because it will be stored anonymously.

Participant's name: ________________________________________________

Participant's signature: ____________________________________________

Date: ______________________

Page 1 of 2

*University of Tasmania*
*School of Psychology*

*Participant Consent Form version 1 22 March 2014*

UTAS

**Statement by Investigator**

☐ I have explained the project and the implications of participation in it to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation.

If the Investigator has not had an opportunity to talk to participants prior to them participating, the following must be ticked.

☐ The participant has received the Information Sheet where my details have been provided so participants have had the opportunity to contact me prior to consenting to participate in this project.

Investigator's name: ____________________________________________

Investigator's signature: ________________________________________

Date: ____________________

## Pre-study Consent Form (1-week delay)

*University of Tasmania*
*School of Psychology*

*Participant Consent Form version 1 22 March 2014*

UTAS

### Creativity and cognition in music – Study B

<u>Participants Consent Form</u>

1. I agree to take part in the research study named above.
2. I have read and understood the Information Sheet for this study.
3. The nature and possible effects of the study have been explained to me.
4. I understand that the study involves composing and listening to melodies using a computer program, during two sessions separated by one week.
5. I understand that there are no foreseeable risks associated with participation in this study.
6. I understand that all research data will be securely stored on the University of Tasmania premises for five years from the publication of the study results, and will then be destroyed unless I give permission for my data to be archived.

   I agree to have my study data archived.

   Yes ☐ No ☐
7. Any questions that I have asked have been answered to my satisfaction.
8. I understand that the researcher(s) will maintain confidentiality and that any information I supply to the researcher(s) will be used only for the purposes of the research.
9. I understand that the results of the study will be published so that I cannot be identified as a participant.
10. I understand that my participation is voluntary and that I may withdraw at any time without any effect.

    I understand that I will not be able to withdraw my data after completing the experiment because it will be stored anonymously.

Participant's name: ______________________________________________

Participant's signature: ____________________________________________

Date: ____________________

Page 1 of 2

*University of Tasmania*
*School of Psychology*

*Participant Consent Form version 1 22 March 2014*

UTAS

## Creativity and cognition in music – Study B

Participants Consent Form

1. I agree to take part in the research study named above.
2. I have read and understood the Information Sheet for this study.
3. The nature and possible effects of the study have been explained to me.
4. I understand that the study involves composing and listening to melodies using a computer program, during two sessions separated by one week.
5. I understand that there are no foreseeable risks associated with participation in this study.
6. I understand that all research data will be securely stored on the University of Tasmania premises for five years from the publication of the study results, and will then be destroyed unless I give permission for my data to be archived.

   I agree to have my study data archived.

   Yes ☐ No ☐
7. Any questions that I have asked have been answered to my satisfaction.
8. I understand that the researcher(s) will maintain confidentiality and that any information I supply to the researcher(s) will be used only for the purposes of the research.
9. I understand that the results of the study will be published so that I cannot be identified as a participant.
10. I understand that my participation is voluntary and that I may withdraw at any time without any effect.

    I understand that I will not be able to withdraw my data after completing the experiment because it will be stored anonymously.

Participant's name: ________________________________________________

Participant's signature: ____________________________________________

Date: ______________________

Page 1 of 2

## Post-study Information Sheet

*University of Tasmania*
*School of Psychology*

*Participant Information Sheet version 1 22 March 2014*

# Unconscious plagiarism in musical tasks: The role of elaboration in source confusion

Information Sheet following Participation in a Research Project

### 1. What is the purpose of this study?

The purpose of this study is to investigate cognitive factors that cause people to confuse melodies they themselves generated with melodies generated by a computer. This type of memory confusion can be thought of as "unconscious plagiarism". The study used a procedure developed by researchers at the University of Plymouth (Stark, Perfect, and Newstead, 2005), which has been used to study unconscious plagiarism in verbal creative tasks. The idea behind the procedure is that editing and reworking ideas that were originally created by others increases the possibility that a person will later unconsciously reproduce these ideas in their own work. This occurs because the cognitive processes involved in creating original ideas and reworking others' ideas are very similar. Some experts think that this offers an explanation for famous cases of music plagiarism such as Bright Tunes Music Corp. v. Harrisongs Music Ltd (1967), where George Harrison's song 'My Sweet Lord' was found to have unconsciously plagiarised The Chiffons' 'He's So Fine' (Perfect & Stark, 2008).

The effectiveness of this procedure has been replicated numerous times in creative tasks, but has only been tested once using a musical task (Rainsford, 2013, Honours dissertation). The primary purpose of this experiment was therefore to replicate these findings in order to confirm whether the paradigm truly explains the circumstances under which unconscious plagiarism occurs in music.

### 2. Important information

It is important to understand that the procedure used in this study is specifically designed to promote confusion between self-generated melodies and melodies generated by the computer. In other words, you can think of the study as a set-up designed to maximise the chances that participants would unconsciously "plagiarise" melodies. Please understand that the responses made by participants in the study do not in any way reflect badly on any individual's creative ability or ethics as a musician.

### 3. How will the data collected from me in this study be analysed?

We will be analysing the results of the recognition test from the second session to test whether participants accidentally confused any of the computer's melodies as their own, or thought that any of their own melodies were created by the computer.

It is important to remember that all melodies included for analysis in this study will be anonymous. That is, if you consent to including your melodies being including in the study for analysis, there will be no way of identifying them as being generated by you.

*University of Tasmania*
*School of Psychology*

*Participant Information Sheet version 1 22 March 2014*

UTAS

You are free to request a copy of the results of this study once the analysis has been conducted. If you wish to do so, please contact either Ms. Rainsford or Dr. Palmer by telephone or email using the contact information provided below.

It is important that you understand that your participation in this study is voluntary. You are free to withdraw from participation without being required to provide an explanation. Your contact details and the data recorded during the experiment will be treated in a confidential manner, and will not be passed on to any person or organization other than the researchers directly involved in this study. Your data will be assigned a unique participant number rather than being stored with any identifying information. The researchers will not have access to your personal contact details, and your name will not be used in any publications following the research.

**4. Are there any possible benefits from participation in this study?**
You will gain experience in research procedures involved in the study of music cognition. The information gained by the researchers will help to confirm the hypothesis of Stark and colleagues (2005) that the three-stage paradigm used in this experiment provides an explanation of the circumstances under which unconscious plagiarism occurs in music. This information may assist musicians wishing to avoid practices that increase the likelihood of unconscious plagiarism.

**5. Are there any possible risks from participation in this study?**
There are no known risks involved in participation in this study. However, if you feel any discomfort as a result of having participated in this study, we are able to arrange for you to discuss any concerns in confidence with a University Student Counsellor. This service is free of charge, tel. (03) 6226 2697.

**6. What if I change my mind during or after the study?**
You are free to withdraw from this study at any time, and you do not have to provide a reason if you decide to leave the study.

If you choose to leave the study, any data collected from you will be removed from the study. Bear in mind that any data already stored in anonymous form will not be able to be identified for removal.

**7. What will happen to the information when this study is over?**

Your information will be stored on a computer disk, with password protected access, available only to the researchers directly associated with the study. All personally identifiable information will be removed, and future reference to your data will be by participant number only.

Your data will be kept for a minimum of five (5) years following the study, in accordance with University and National requirements, after which time it will be securely disposed of.

*University of Tasmania*
*School of Psychology*

*Participant Information Sheet version 1 22 March 2014*

### 8. How will the results of the study be published?

The results of the study will be published as Miriam Rainsford's PhD thesis. A copy of this study will be stored in the University of Tasmania Morris Miller Library. The results will also be submitted for publication in an academic journal. You may request a copy of the results of the study. Participants' data will not be identifiable in any resulting publication.

### 9. What if I have questions about this study?

If you would like further information, or have any questions about this study, please feel free to contact:

Ms. Miriam Rainsford (03 6226 7458 or miriam.rainsford@utas.edu.au)
Dr. Matthew Palmer (03 6324 3004 or matthew.palmer@utas.edu.au)

If you are a student of the University of Tasmania, you may wish to discuss any concerns in confidence with a University Student Counsellor. This service is free of charge, tel. (03) 6226 2697.

This study has been approved by the Tasmanian Social Sciences Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, please contact the Executive Officer of the HREC (Tasmania) Network on (03) 6226 7479 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. Please quote ethics reference number H12345

**This information sheet is yours to keep following the study.**

**Thank you for taking the time to consider this information. If you are happy for the data collected from you during the study to be used, please sign the attached consent form.**

**References:**

Bailes, F. (2010). Dynamic melody recognition: Distinctiveness and the role of musical expertise. *Memory and Cognition, 38,* 641-650. doi:10.3758/MC.38.5.641

Bright Tunes Music Corp. v. Harrisongs Music, Ltd. (1976). Retrieved 7 April, 2013, from http://www.law.berkeley.edu/files/Bright_Tunes_Music_v_Harrisongs.pdf

Perfect, T J., & Stark, L-J. (2008a). Tales from the crypt… omnesia, in J. Dunlosky & R. Bjork (Eds.), *A handbook of memory and metamemory*. New York: LEA, pp. 285-314.

Perfect, T. J., & Stark, L.-J. (2008b). Why do I always have the best ideas? The role of idea quality in unconscious plagiarism. *Memory, 16,* 386-394. doi:10.1080/09658210801946501

Rainsford, M. A. E. (2013). *Unconscious plagiarism in music.* Honours dissertation, University of Tasmania, 2013.

Stark, L-J., Perfect, T. J. & Newstead. S. (2005) When elaboration leads to appropriation: Unconscious plagiarism in a creative task. *Memory, 13,* 561-573. doi:10.1080/09658210444000232

Stark, L-J., & Perfect, T. J. (2008). The effects of repeated idea elaboration on unconscious plagiarism. *Memory and Cognition, 36,* 65-73. doi:10.3758/MC.36.1.65

## Post-study Consent Form

*University of Tasmania*
*School of Psychology*

*Participant Consent Form version 1 30 April 2013*

UTAS

# Unconscious plagiarism in musical tasks: The role of elaboration in source confusion

Participants Consent Form

1. I agree to take part in the research study named above.
2. I have read and understood the Information Sheet for this study.
3. The nature and possible effects of the study have been explained to me.
4. I understand that the data collected from me during the experimental sessions was for the purposes of studying unconscious plagiarism in music. I understand that the procedure used in this experiment was designed to maximise the chances of unconscious plagiarism. I understand that the data collected in the Recognition test will be analysed for accuracy in recognising the source of the melodies.
5. I understand that there are no foreseeable risks associated with participation in this study.
6. I understand that all research data will be securely stored on the University of Tasmania premises for five years from the publication of the study results, and will then be destroyed unless I give permission for my data to be archived

   I agree to have my study data archived.

   Yes ☐ No ☐
7. Any questions that I have asked have been answered to my satisfaction.
8. I understand that the researcher(s) will maintain confidentiality and that any information I supply to the researcher(s) will be used only for the purposes of the research.
9. I understand that the results of the study will be published so that I cannot be identified as a participant.
10. I understand that my participation is voluntary and that I may withdraw at any time without any effect.

    I understand that I will not be able to withdraw my data after completing the experiment because it will be stored anonymously.

*University of Tasmania*
*School of Psychology*

*Participant Consent Form version 1 30 April 2013*

UTAS

Participant's name: ____________________________________________

Participant's signature: _________________________________________

Date: ____________________

**Statement by Investigator**

☐ I have explained the project and the implications of participation in it to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation.

If the Investigator has not had an opportunity to talk to participants prior to them participating, the following must be ticked.

☐ The participant has received the Information Sheet where my details have been provided so participants have had the opportunity to contact me prior to consenting to participate in this project.

Investigator's name: ____________________________________________

Investigator's signature: _________________________________________

Date: ____________________

## Questionnaire

*University of Tasmania*
*School of Psychology*

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### Creativity and Cognition in Music – Study B

Research Project Questionnaire

Participant ID:………………..

Age: …………………………..Digit Span Result:…….

For how many years have you played and/or composed music?

……………………………………………………………………………………

Have you taken music lessons privately? If so, for how many years did you have lessons?

……………………………………………………………………………………

Did you study an instrument at high school? If so, for how many years did you have lessons?

……………………………………………………………………………………

Have you ever performed live as a musician, or had your compositions released as a recording?

……………………………………………………………………………………

What is your instrument/voice?

……………………………………………………………………………………

Do you compose music?

……………………………………………………………………………………

Do you perform or compose mainly classical, popular music or both?

……………………………………………………………………………………

Do you prefer to listen to mainly classical, popular music, or both?

……………………………………………………………………………………

How many hours per week would you spend listening to music?

……………………………………………………………………………………

*University of Tasmania*
*School of Psychology*

How many hours per week would you spend practicing or playing music?

……………………………………………………………………………………………

Do you have absolute pitch ("perfect pitch")?

……………………………………………………………………………………………

Please rate your agreement with the following statements, on a scale of 1 to 7, where:

1 = strongly disagree
2 = disagree
3 = somewhat disagree
4 = neither agree nor disagree
5 = somewhat agree
6 = agree
7 = strongly agree

There are no right or wrong answers, simply choose the number that best reflects your opinion.

"I enjoy using samples in my music, or listening to music made from samples or quotations of other people's music".

……………………………………………………………………………………………

"Musicians should always compose original new works. Musicians should never copy or make reference to the work of another musician".

……………………………………………………………………………………………

"'Mashups' and collages made from other people's work are art forms too. I don't think there is anything wrong with re-using someone else's work to make new art."

……………………………………………………………………………………………

"The work I do should always be 100% original. I would never copy or make reference to the work of another musician".

……………………………………………………………………………………………

**Final page of Questionnaire and manipulation checks**

**(Given after full information sheet was provided)**

*University of Tasmania*
*School of Psychology*

UTAS

Post-debriefing questions

After any of the experimental sessions, could you hear any of the melodies, or a general flavor of the melodies repeating in your head like a “stuck tune” or “earworm”?

…………………………………………………………………………………………

If so, please rate how persistent was the “stuck tune” was on a scale of 1 to 4, where:

1 = not persistent, I did not experience any stuck tunes
2 = mildly persistent, I could hear a general flavour of the melodies in my mind for a few moments after leaving the experiment
3 = moderately persistent, I could hear some melodies specifically, or melodies mixed together, for 30 minutes or more after leaving the experiment
4 = very persistent, I could not get the tunes out of my head, or had to listen to other music

…………………………………………………………………………………………

Was there any one melody that was particularly “sticky” or “catchy”?

…………………………………………………………………………………………

Have you heard of Stark and Perfect’s (2008) theories about reworking ideas and unconscious plagiarism before?

…………………………………………………………………………………………

Were you aware prior to participating in this experiment that the study was about unconscious plagiarism?

…………………………………………………………………………………………

**Appendix 3** Study 4 Forms

## Pre-study Information Sheet

*University of Tasmania*
*School of Psychology*

*Participant Information Sheet version 1 22 March 2014*

# Creativity and cognition in music - Study C

Information Sheet for Participation in a Research Project

### 1. Invitation

You are invited to participated in a research study into various aspects of music cognition, including the effects of time delays, on the completion of a creative task.

This study is being conducted in partial fulfillment of the degree of Doctor of Philosophy (PhD) in Psychology for Ms. Miriam Rainsford, under the supervision of Dr. Matthew Palmer.

### 2. What is the purpose of this study?

The purpose of this study is to investigate the effect of various aspects of music cognition, including the effects of time delays, on the completion of a creative task. Creativity has been observed to occur in cycles, with moments of illumination, or 'lightbulb moments', being those at which a breakthrough in creativity occurs. These have often been observed to occur at the point at which one takes a break from working at a creative task. For this reason we will be conducting the study across two sessions separated by one week, to study the effect of time delays on creativity.

### 3. Why have I been invited to participate?

You are eligible to participate in this study as someone who is over 18 years of age, and who has experience in playing music, e.g. has studied music at high school, or enjoys amateur music making at home or with a band.

It is important that you understand that your participation in this study is voluntary. You may choose to leave the study at any time, without being required to provide an explanation. Your contact details and the data recorded during the experiment will be treated in a confidential manner, and will be assigned a unique participant number. The researchers will not have access to your personal contact details, and your name will not be used in any publications following the research.

### 4. What will I be asked to do?

You will be asked to compose, listen to, and edit melodies using a computer program, across two sessions of data collection.

You will be given an Arabic musical scale, known as a 'maqam', and a classical Arabic poem. You will be asked to compose melodies to suit your interpretation of the poem using a computer program, and to listen to and edit melodies generated by the computer.

Each session is expected to take around one hour. No information will be recorded other than your responses to the computer program, and a short demographic questionnaire on your music listening habits and interests, and length of musical training.

*University of Tasmania*
*School of Psychology*

*Participant Information Sheet version 1 22 March 2014*

**5. Are there any possible benefits from participation in this study?**
You will gain experience in research procedures involved in the study of music cognition. The information gained by the researchers will help to confirm the results of previous experiments, and will further the understanding of creative processes in music.

**6. Are there any possible risks from participation in this study?**
There are no known risks involved in participation in this study.

**7. What if I change my mind during or after the study?**
You are free to withdraw from this study at any time, and you do not have to provide a reason if you decide to leave the study. If you choose to leave the study after completing the experiment, you will not be able to withdraw your data because it will be anonymous.

**8. What will happen to the information when this study is over?**
Your information will be stored on a computer disk, with password protected access, available only to the researchers. All personally identifiable information will be removed, and future reference to your data will be by participant number only.

Your data will be kept for a minimum of five (5) years following the study, in accordance with University and National requirements, after which time it will be securely disposed of.

**9. How will the results of the study be published?**
The results of the study will be published as Miriam Rainsford's PhD thesis. A copy of this study will be stored in the University of Tasmania Morris Miller Library. The results will also be submitted for publication in an academic journal. You may request a copy of the results of the study. Participants' data will not be identifiable in the publication.

**10. What if I have questions about this study?**
If you would like further information, please contact:

Ms. Miriam Rainsford (03 6226 7458 or miriam.rainsford@utas.edu.au)
Dr. Matt Palmer (03 6324 3004 or matthew.palmer@utas.edu.au)

If you are a student of the University of Tasmania, you may wish to discuss any concerns in confidence with a University Student Counsellor. This service is free of charge, tel. (03) 6226 2697.

This study has been approved by the Tasmanian Social Sciences Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, please contact the Executive Officer of the HREC (Tasmania) Network on (03) 6226 7479 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. Please quote ethics reference number H12345

**This information sheet is yours to keep following the study.**

**Thank you for taking the time to consider this study. If you wish to take part in the study, please sign the attached consent form.**

## Pre-study Consent Form

*University of Tasmania*
*School of Psychology*

*Participant Consent Form version 1 22 March 2014*

UTAS

# Creativity and cognition in music – Study C

Participants Consent Form

1. I agree to take part in the research study named above.
2. I have read and understood the Information Sheet for this study.
3. The nature and possible effects of the study have been explained to me.
4. I understand that the study involves composing and listening to melodies using a computer program, during two sessions separated by one week.
5. I understand that there are no foreseeable risks associated with participation in this study.
6. I understand that all research data will be securely stored on the University of Tasmania premises for five years from the publication of the study results, and will then be destroyed unless I give permission for my data to be archived.

   I agree to have my study data archived.

   Yes ☐ No ☐
7. Any questions that I have asked have been answered to my satisfaction.
8. I understand that the researcher(s) will maintain confidentiality and that any information I supply to the researcher(s) will be used only for the purposes of the research.
9. I understand that the results of the study will be published so that I cannot be identified as a participant.
10. I understand that my participation is voluntary and that I may withdraw at any time without any effect.

    I understand that I will not be able to withdraw my data after completing the experiment because it will be stored anonymously.

Participant's name: ________________________________________________

Participant's signature: ______________________________________________

Date: ______________________

Page 1 of 2

*University of Tasmania*
*School of Psychology*

*Participant Consent Form version 1 22 March 2014*

**Statement by Investigator**

☐ I have explained the project and the implications of participation in it to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation.

If the Investigator has not had an opportunity to talk to participants prior to them participating, the following must be ticked.

☐ The participant has received the Information Sheet where my details have been provided so participants have had the opportunity to contact me prior to consenting to participate in this project.

Investigator's name: ___________________________________________________

Investigator's signature: ______________________________________________

Date: ______________________

**Post-study Information Sheet**

*University of Tasmania*
*School of Psychology*

*Participant Information Sheet version 1 22 March 2014*

UTAS

# Unconscious plagiarism in musical tasks: Pilot testing an intervention to reduce plagiarism

Information Sheet following Participation in a Research Project

### 1. What is the purpose of this study?

The purpose of this study is to investigate cognitive factors that cause people to confuse melodies they themselves generated with melodies generated by a computer. This type of memory confusion can be thought of as "unconscious plagiarism". The study used a procedure developed by researchers at the University of Plymouth (Stark, Perfect, and Newstead, 2005), which has been used to study unconscious plagiarism in verbal creative tasks. The idea behind the procedure is that editing and reworking ideas that were originally created by others increases the possibility that a person will later unconsciously reproduce these ideas in their own work. This occurs because the cognitive processes involved in creating original ideas and reworking others' ideas are very similar. Some experts think that this offers an explanation for famous cases of music plagiarism such as Bright Tunes Music Corp. v. Harrisongs Music Ltd (1967), where George Harrison's song 'My Sweet Lord' was found to have unconsciously plagiarised The Chiffons' 'He's So Fine' (Perfect & Stark, 2008).

The effectiveness of this procedure has been replicated numerous times in creative tasks with similar tasks, and was recently replicated in music (Rainsford, 2013, Honours dissertation). As unconscious plagiarism has now been demonstrated across domains, the purpose of this experiment was therefore to test a potential intervention to reduce the likelihood of unconscious plagiarism. A simple musical device which plays "musical white noise", consisting of endless sequences of the twelve notes of the Western chromatic scale in equal amounts, was developed. It is hoped that this will function as a form of distractor task, reducing recall of the computer-generated melodies in a similar way to distractor tasks in word recall (Peterson & Peterson, 1959).

### 2. Important information

It is important to understand that the procedure used in this study is specifically designed to promote confusion between self-generated melodies and melodies generated by the computer. In other words, you can think of the study as a set-up designed to maximise the chances that participants would unconsciously "plagiarise" melodies. Please understand that the responses made by participants in the study do not in any way reflect badly on any individual's creative ability or ethics as a musician.

### 3. How will the data collected from me in this study be analysed?

We will be analysing the results of the recognition test from the second session to test whether participants accidentally confused any of the computer's melodies as their own, or thought that any of their own melodies were created by the computer.

*University of Tasmania*
*School of Psychology*

*Participant Information Sheet version 1 22 March 2014*

UTAS

It is important to remember that all melodies included for analysis in this study will be anonymous. That is, if you consent to including your melodies being including in the study for analysis, there will be no way of identifying them as being generated by you.

You are free to request a copy of the results of this study once the analysis has been conducted. If you wish to do so, please contact either Ms. Rainsford or Dr. Palmer by telephone or email using the contact information provided below.

It is important that you understand that your participation in this study is voluntary. You are free to withdraw from participation without being required to provide an explanation. Your contact details and the data recorded during the experiment will be treated in a confidential manner, and will not be passed on to any person or organization other than the researchers directly involved in this study. Your data will be assigned a unique participant number rather than being stored with any identifying information. The researchers will not have access to your personal contact details, and your name will not be used in any publications following the research.

**4. Are there any possible benefits from participation in this study?**
You will gain experience in research procedures involved in the study of music cognition. The information gained by the researchers will help to confirm the hypothesis of Stark and colleagues (2005) that the three-stage paradigm used in this experiment provides an explanation of the circumstances under which unconscious plagiarism occurs in music. This information may assist musicians wishing to avoid practices that increase the likelihood of unconscious plagiarism.

**5. Are there any possible risks from participation in this study?**
There are no known risks involved in participation in this study. However, if you feel any discomfort as a result of having participated in this study, we are able to arrange for you to discuss any concerns in confidence with a University Student Counsellor. This service is free of charge, tel. (03) 6226 2697.

**6. What if I change my mind during or after the study?**
You are free to withdraw from this study at any time, and you do not have to provide a reason if you decide to leave the study.

If you choose to leave the study, any data collected from you will be removed from the study. Bear in mind that any data already stored in anonymous form will not be able to be identified for removal.

**7. What will happen to the information when this study is over?**

Your information will be stored on a computer disk, with password protected access, available only to the researchers directly associated with the study. All personally identifiable information will be removed, and future reference to your data will be by participant number only.

*University of Tasmania*
*School of Psychology*

*Participant Information Sheet version 1 22 March 2014*

Your data will be kept for a minimum of five (5) years following the study, in accordance with University and National requirements, after which time it will be securely disposed of.

**8. How will the results of the study be published?**
The results of the study will be published as Miriam Rainsford's PhD thesis. A copy of this study will be stored in the University of Tasmania Morris Miller Library. The results will also be submitted for publication in an academic journal. You may request a copy of the results of the study. Participants' data will not be identifiable in any resulting publication.

**9. What if I have questions about this study?**
If you would like further information, or have any questions about this study, please feel free to contact:

Ms. Miriam Rainsford (03 6226 7458 or miriam.rainsford@utas.edu.au)
Dr. Matthew Palmer (03 6324 3004 or matthew.palmer@utas.edu.au)

If you are a student of the University of Tasmania, you may wish to discuss any concerns in confidence with a University Student Counsellor. This service is free of charge, tel. (03) 6226 2697.

This study has been approved by the Tasmanian Social Sciences Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, please contact the Executive Officer of the HREC (Tasmania) Network on (03) 6226 7479 or email human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. Please quote ethics reference number H12345

**This information sheet is yours to keep following the study.**

**Thank you for taking the time to consider this information. If you are happy for the data collected from you during the study to be used, please sign the attached consent form.**

**References:**

Bailes, F. (2010). Dynamic melody recognition: Distinctiveness and the role of musical expertise. *Memory and Cognition, 38,* 641-650. doi:10.3758/MC.38.5.641
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Perfect, T. J., & Stark, L.-J. (2008b). Why do I always have the best ideas? The role of idea quality in unconscious plagiarism. *Memory, 16,* 386-394. doi:10.1080/09658210801946501
Peterson, L. , & Peterson, M. J. (1959) Short term retention of individual verbal items. *Journal of Experimental Psychology, 58,* 193-198.
Rainsford, M. A. E. (2013). *Unconscious plagiarism in music.* Honours dissertation, University of Tasmania, 2013.
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Stark, L-J., & Perfect, T. J. (2008). The effects of repeated idea elaboration on unconscious plagiarism. *Memory and Cognition, 36,* 65-73. doi:10.3758/MC.36.1.65

## Post-study Consent Form

*University of Tasmania*
*School of Psychology*

*Participant Consent Form version 1 30 April 2013*

UTAS

# Unconscious plagiarism in musical tasks: Pilot testing an intervention to reduce plagiarism

Participants Consent Form

1. I agree to take part in the research study named above.
2. I have read and understood the Information Sheet for this study.
3. The nature and possible effects of the study have been explained to me.
4. I understand that the data collected from me during the experimental sessions was for the purposes of studying unconscious plagiarism in music, and for the purposes of testing a possible intervention to assist in reducing the likelihood that a musician may plagiarise. I understand that the procedure used in this experiment was designed to maximise the chances of unconscious plagiarism. I understand that the data collected in the Recognition test will be analysed for accuracy in recognising the source of the melodies.
5. I understand that there are no foreseeable risks associated with participation in this study.
6. I understand that all research data will be securely stored on the University of Tasmania premises for five years from the publication of the study results, and will then be destroyed unless I give permission for my data to be archived

   I agree to have my study data archived.

   Yes ☐ No ☐
7. Any questions that I have asked have been answered to my satisfaction.
8. I understand that the researcher(s) will maintain confidentiality and that any information I supply to the researcher(s) will be used only for the purposes of the research.
9. I understand that the results of the study will be published so that I cannot be identified as a participant.
10. I understand that my participation is voluntary and that I may withdraw at any time without any effect.

    I understand that I will not be able to withdraw my data after completing the experiment because it will be stored anonymously.

*University of Tasmania*
*School of Psychology*

*Participant Consent Form version 1 30 April 2013*

Participant's name: ___________________________________________________

Participant's signature: ______________________________________________

Date: ______________________

**Statement by Investigator**

☐ I have explained the project and the implications of participation in it to this volunteer and I believe that the consent is informed and that he/she understands the implications of participation.

If the Investigator has not had an opportunity to talk to participants prior to them participating, the following must be ticked.

☐ The participant has received the Information Sheet where my details have been provided so participants have had the opportunity to contact me prior to consenting to participate in this project.

Investigator's name: ___________________________________________________

Investigator's signature: ______________________________________________

Date: ______________________

## Questionnaire

*University of Tasmania*
*School of Psychology*

UTAS

### Creativity and Cognition in Music – Study C

Research Project Questionnaire

Participant ID:………………..

Age: …………………………..Digit Span Result:…….

For how many years have you played and/or composed music?

…………………………………………………………………………………………

Have you taken music lessons privately? If so, for how many years did you have lessons?

…………………………………………………………………………………………

Have you studied music at tertiary level? (e.g. Conservatorium, or a music diploma) If so, for how long?

…………………………………………………………………………………………

Did you study an instrument at high school? If so, for how many years did you have lessons?

…………………………………………………………………………………………

Have you ever performed live as a musician, or had your compositions released as a recording?

…………………………………………………………………………………………

What is your instrument/voice?

…………………………………………………………………………………………

Do you compose music?

…………………………………………………………………………………………

Do you perform or compose mainly classical, popular music or both?

…………………………………………………………………………………………

Do you prefer to listen to mainly classical, popular music, or both?

…………………………………………………………………………………………

*University of Tasmania*
*School of Psychology*

UTAS

How many hours per week would you spend listening to music?

……………………………………………………………………………………………

How many hours per week would you spend practicing or playing music?

……………………………………………………………………………………………

Do you have absolute pitch ("perfect pitch")?

……………………………………………………………………………………………

Please rate your agreement with the following statements, on a scale of 1 to 7, where:

1 = strongly disagree
2 = disagree
3 = somewhat disagree
4 = neither agree nor disagree
5 = somewhat agree
6 = agree
7 = strongly agree

There are no right or wrong answers, simply choose the number that best reflects your opinion.

"I enjoy using samples in my music, or listening to music made from samples or quotations of other people's music".

……………………………………………………………………………………………

"Musicians should always compose original new works. Musicians should never copy or make reference to the work of another musician".

……………………………………………………………………………………………

"'Mashups' and collages made from other people's work are art forms too. I don't think there is anything wrong with re-using someone else's work to make new art."

……………………………………………………………………………………………

"The work I do should always be 100% original. I would never copy or make reference to the work of another musician".

……………………………………………………………………………………………

**Final page of Questionnaire and manipulation checks**

**(Given after full information sheet was provided)**

*University of Tasmania*
*School of Psychology*

UTAS

Post-debriefing questions

After any of the experimental sessions, could you hear any of the melodies, or a general flavor of the melodies repeating in your head like a “stuck tune” or “earworm”?

………………………………………………………………………………………………

If so, please rate how persistent was the “stuck tune” was on a scale of 1 to 4, where:

1 = not persistent, I did not experience any stuck tunes
2 = mildly persistent, I could hear a general flavour of the melodies in my mind for a few moments after leaving the experiment
3 = moderately persistent, I could hear some melodies specifically, or melodies mixed together, for 30 minutes or more after leaving the experiment
4 = very persistent, I could not get the tunes out of my head, or had to listen to other music

………………………………………………………………………………………………

Was there any one melody that was particularly “sticky” or “catchy”?

………………………………………………………………………………………………

Have you heard of Stark and Perfect’s (2008) theories about reworking ideas and unconscious plagiarism before?

………………………………………………………………………………………………

Were you aware prior to participating in this experiment that the study was about unconscious plagiarism?

………………………………………………………………………………………………

**Appendix 4** Software developed for this research

**Studies 1 and 2**

The MUSOS Toolkit may be downloaded from the link below. The zip file includes all program files, stimulus set, sample data and Excel spreadsheets for data analysis.

http://www.soundinmind.net/MUSOS/MUSOS.zip

**Study 3**

This version of MUSOS was developed to present the Brown and Murphy (1989) three-stage paradigm, including manipulations of imagery and idea improvement adapted for use with musical stimuli.

http://www.soundinmind.net/data/UPProgram.zip

**Study 4**

The program used in Study 3 was modified to include a two-minute intervention consisting of randomly generated musical notes. This was presented to participants either at the end of Session 1, after idea generation and elaboration, or at the start of Session 2, prior to generating new melodies and completing the recognition test. Control group participants used the same program as for Study 3.

http://www.soundinmind.net/data/InterventionProgram.zip

**Software licensing**

All software used in the studies was developed for this research project by Miriam Rainsford and Garth Paine. This software is released under the GNU General Public License (GPL) 3.0 (Free Software Foundation, 2007).